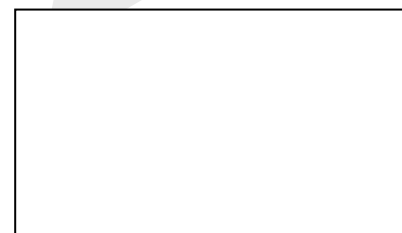
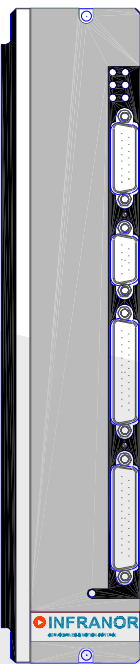


SMT-BD2

gb

**DIGITAL SERVO DRIVE
FOR SINUSOIDAL
BRUSHLESS AC MOTORS**



WARNING !



This is a general manual describing a series of servo amplifiers having output capability suitable for driving AC brushless sinusoidal servo motors.

Instructions for storage, use after storage, commissioning as well as all technical details require the MANDATORY reading of the manual before getting the amplifiers operational.

Maintenance procedures should be attempted only by highly skilled technicians having good knowledge of electronics and servo systems with variable speed (EN 60204-1 standard) and using proper test equipment.

The conformity with the standards and the "CE" approval is only valid if the items are installed according to the recommendations of the amplifier manuals. Connections are the user's responsibility if recommendations and drawings requirements are not met.



Any contact with electrical parts, even after power down, may involve physical damage. Wait for at least 5 minutes after power down before handling the amplifiers (a residual voltage of several hundreds of volts may remain during a few minutes).



ESD INFORMATION (ElectroStatic Discharge)

INFRANOR amplifiers are conceived to be best protected against electrostatic discharges. However, some components are particularly sensitive and may be damaged if the amplifiers are not properly stored and handled.

STORAGE

- The amplifiers must be stored in their original package.
- When taken out of their package, they must be stored positioned on one of their flat metal surfaces and on a dissipating or electrostatically neutral support.
- Avoid any contact between the amplifier connectors and material with electrostatic potential (plastic film, polyester, carpet...).

HANDLING

- If no protection equipment is available (dissipating shoes or bracelets), the amplifiers must be handled via their metal housing.
- Never get in contact with the connectors



ELIMINATION

In order to comply with the 2002/96/EC directive of the European Parliament and of the Council of 27 January 2003 on waste electrical and electronic equipment (WEEE), all INFRANOR devices have got a sticker symbolizing a crossed-out wheel dustbin as shown in Appendix IV of the 2002/96/EC Directive.

This symbol indicates that INFRANOR devices must be eliminated by selective disposal and not with standard waste.

INFRANOR does not assume any responsibility for any physical or material damage due to improper handling or wrong descriptions of the ordered items.

Any intervention on the items, which is not specified in the manual, will immediately cancel the warranty.

Infranor reserves the right to change any information contained in this manual without notice.

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Chapter 1 - General description

1 - INTRODUCTION

Series **SMT-BD2** digital servo modules are sinusoidal PWM power amplifiers that provide speed and torque/force control for AC brushless motors equipped with encoder only or encoder with Hall Effect Sensors (HES) for the position feedback. The speed or torque/force input command is a +/-10 V analog signal voltage.

The **SMT-BD2** digital servo drive is 220 VAC or 400 VAC main operated. The **SMT-BD2** plug-in system with 400 VAC power supply is available as a multi-axis version that can receive up to three axes in a standard 19" rack including the power supply. The **SMT-BD2** plug-in system with 220 VAC power supply is available as a single-axis block version or as a multi-axis version that can receive up to six axes in a standard 19" rack including the power supply.

2 - GENERAL DESCRIPTION

Series **SMT-BD2** amplifiers have their own DC/DC converter to provide the appropriate supply voltage (+5 V, +15 V, -15V). The source supply voltage for the logic board is the auxiliary 310 VDC supply voltage. The auxiliary supply voltage allows to have the position output signals still available when the power supply voltage is turned off.

Each module is packaged as a 6 U "double Eurocard":

- one power board with IGBT transistors
- one logic board with DSP (Digital Signal Processing).

The **SMT-BD2** amplifier directly controls the motor torque/force and speed by means of the information provided by an encoder feedback device. The sinusoidal current commutation based on encoder feedback provides smooth motor torque/force control.

The **SMT-BD2** amplifier can be configured for various encoder types feedback. The appropriate encoder input configuration is selectable by jumpers.

- With an incremental encoder only, a motor phasing procedure must be executed at each amplifier power up before the motor enabling.
- With an incremental encoder + HES feedback from the motor, the motor phasing procedure is no more necessary and the servo motor can immediately be enabled after the amplifier power up.
- With an absolute single turn SinCos encoder feedback from the motor (Heidenhain ERN 1085 or compatible), the servo motor can also immediately be enabled after the amplifier power up.

The motor speed or torque/force input command is a +/-10 V analog voltage. The motor position output is available as two A and B encoder type channels in quadrature, and one Z marker pulse per revolution via RS422 line drivers. The ratio between the number of pulses on the motor encoder and the number of pulses on the **SMT-BD2** amplifier encoder output is programmable.

The amplifier faults are displayed on the front panel and can also be read via the serial link.

All control parameters are programmable by means of the serial link and saved in an EEPROM. The auto-configuration and auto-tuning functions allow an easy and quick commissioning of the amplifier.

The **Visual Drive Setup** software, which is IBM-PC compatible with the WINDOWS® operating system, allows the clear display and easy modification of all amplifier parameters. The **Visual Drive Setup** software also includes a digitizing oscilloscope function that is particularly useful for the drive commissioning and maintenance.

3 - REFERENCE TO THE STANDARDS

The 220 VAC version of the **SMT-BD2** amplifiers operating in the BF rack, which is equipped with the mains filter BF-35 or 70, has been approved for its conformity with the Electromagnetic Compatibility standards:

- EN 55011, Group 1, Class A regarding the conducted and radiated radioelectric disturbances,
- CEI 801 - 2 - 3 - 4 regarding the immunity.

The 220 VAC version of the SMT-BD2 amplifiers operating in the single axis BM20 A – BMM05F – BMM05AF, which is equipped with appropriate mains filter (FN 612-20/06 or FN 356-16/06) has been approved for its conformity with the Electromagnetic Compatibility standards:

- EN 55011, Group 1, Class A regarding the conducted and radiated radioelectric disturbances,
- CEI 801 - 2 - 3 – 4 regarding the immunity.

The 400 VAC version of the **SMT-BD2** amplifiers operating in the BF-400 rack, which is equipped with the mains filter F400-35 or 70, has been approved for its conformity with the Electromagnetic Compatibility standards:

- EN 55011, Group 1, Class A regarding the conducted and radiated radioelectric disturbances,
- CEI 801 - 2 - 3 - 4 regarding the immunity.

Standard to be applied to the electrical equipments of industrial machines: EN 60204.1.

The SMT-BD2 amplifiers have been "CE" marked since year 2000.

4 - REFERENCE TO OTHER DOCUMENTS

- ◆ **BF-400 rack** – for the use of the 400 VAC amplifier version in a multi-axis rack.
- ◆ **BF rack** – for the use of the 220VAC amplifier version in a multi-axis rack.
- ◆ **BM20A/BMM05F/05AF single-axis rack** – for the use of the 220 VAC amplifier version in a single-axis rack.

Chapter 2 – Specifications

1 - TECHNICAL SPECIFICATIONS

1.1 - CURRENT RATINGS FOR THE 220 VAC AMPLIFIER VERSION

Operating voltage	DC bus 310 VDC (270 VDC < DC bus < 340 VDC max.)
Auxiliary supply voltage	310 VDC (200 VDC < Uaux < 340 VDC max.)
Motor terminal to terminal output voltage	200 Vrms for 310 VDC bus

Authorized output currents for current pulse mode operation (I_{2t} protection in fusing mode)

AMPLIFIER	U rated (Vrms)	I _{max} (Arms) 1 s	Max. authorized rated current (Arms) of the amplifier		
			WITHOUT FAN*	FAN TYPE 1*	FAN TYPE 2*
SMT-BD2 - 220/04	240	4,4	2		
SMT-BD2 - 220/08	240	8,8	4		
SMT-BD2 - 220/12	240	13,8	6		
SMT-BD2 - 220/17	240	17,7	8,5		
SMT-BD2 - 220/30	240	30,8	10	12	15
SMT-BD2 - 220/30r	240	30,8	10	15	
SMT-BD2 - 220/45	240	48,6	10	15	20
SMT-BD2 - 220/45r	240	48,6	10	20	23
SMT-BD2 - 220/60	240	61	10	19	25
SMT-BD2 - 220/60r	240	61	12	26	30
SMT-BD2 - 220/70	240	70	25	30	35
SMT-BD2 - 220/100	240	100	25	30	35

Authorized output currents for **continuous current mode** operation (I²t protection in limiting mode)

AMPLIFIER TYPE	U _{rated} (Vrms)	I _{max} (Arms) 1 s	Max. authorized continuous current (Arms) of the amplifier		
			WITHOUT FAN*	FAN TYPE 1*	FAN TYPE 2*
SMT-BD2 - 220/04	240	4,4	2		
SMT-BD2 - 220/08	240	8,8	4		
SMT-BD2 - 220/12	240	13,8	6		
SMT-BD2 - 220/17	240	17,7	8,5	8,5	
SMT-BD2 - 220/30	240	30,8	8,5	12	15
SMT-BD2 - 220/30r	240	30,8	10	15	
SMT-BD2 - 220/45	240	48,6	8,5	15	18
SMT-BD2 - 220/45r	240	48,6	10	20	23
SMT-BD2 - 220/60	240	61	8,5	17	20
SMT-BD2 - 220/60r	240	61	12	26	30
SMT-BD2 - 220/70	240	70	17	30	35
SMT-BD2 - 220/100	240	100	25	30	35

* Maximum ambient temperature = + 40° C, fan 1 = 56 l/s, fan 2 = 90 l/s.

Note: The **SMT-BD2-X/Xr** amplifier types are equipped with an additional heatsink in order to improve the heat dissipation and increase their rated current. The width of these amplifier types is then 18 TE instead of 12 TE.

Minimum inductance between phases

1 mH

Conformity with the standards: **CE** approval with multiaxis power supply configuration BF rack and mains filter BF-35 or 70, or SMTB.M 20 A single-axis rack and BF 35 filter. "360°" shields; equipotentiality according to the wiring rules.

- EMC standards

Immunity: CEI standards 801- 2 - 3 - 4
Conducted and radiated disturbances: EN 55011, Group 1, class A

- Electrical standards for industrial machines:
EN 60204.1: - Insulator: 1500 VAC/1 min.
- Leakage current > 3 mA
(EMI filters)

Temperature range

* storage - 20°C to + 70°C

* operation 5°C to +40°C

From 40°C on, the rated currents must be reduced of 3 %/°C.

Max. temperature: 50°C

1.2-CURRENT RATINGS FOR THE 400 VAC AMPLIFIER VERSION

Operating voltage

DC bus 565 VDC (480 VDC < DC bus < 685 VDC max.)

Auxiliary supply voltage

310 VDC (200 VDC < Uaux < 340 VDC max.)

Motor terminal to terminal output voltage

380Vrms for 565 VDC bus

Authorized output currents for **current pulse mode** operation (I^2t protection in fusing mode)

AMPLIFIER	U rated (Vrms)	Imax (Arms) 1 s	Max. authorized rated current (Arms) of the amplifier	
			WITHOUT FAN*	FAN TYPE 2*
SMT-BD2 - 400/15	400	15.5	5	7.5
SMT-BD2 - 400/30	400	30	8	15
SMT-BD2 - 400/45	400	48	10	19
SMT-BD2 - 400/60	400	60	not used	28
SMT-BD2 - 400/100	400	100	not used	35

Authorized output currents for **continuous current mode** operation (I^2t protection in limiting mode)

AMPLIFIER TYPE	U rated (Vrms)	Imax (Arms) 1 s	Max. authorized continuous current (Arms) of the amplifier	
			WITHOUT FAN*	FAN TYPE 2*
SMT-BD2 - 400/15	400	15.5	not used	5
SMT-BD2 - 400/30	400	30	not used	10
SMT-BD2 - 400/45	400	48	not used	15
SMT-BD2 - 400/60	400	60	not used	23
SMT-BD2 - 400/60	400	100	not used	28

* Maximum ambient temperature = + 40° C, fan 2 = 90 l/s.

Minimum inductance between phases

2 mH

Conformity with the standards: **CE** approval - EMC standards

with multiaxis power supply configuration

BF-400 rack and mains filter F400-35 or 70.

"360°" shields; equipotentiality according to the wiring rules.

Immunity: CEI standards 801- 2 - 3 - 4

Conducted and radiated disturbances: EN 55011, Group 1, class A

- Electrical standards for industrial machines:

EN 60204.1: - Insulator: 2500 VDC/1 min.

- Leakage current > 3 mA

(EMI filters without condensators)

Temperature range

* storage - 20°C to + 70°C

* operation 5°C to +40°C

From 40°C on, the rated currents must be reduced of 3 %/°C.

Max. temperature: 50°C

1.3 - OTHER SPECIFICATIONS

PWM switching frequency	10 KHz
Current regulator (PI)	Adjusted to motor
Current loop bandwidth	Cut-off frequency for 45° phase shift > 1 KHz
Internal current limitation	Maximum current range : 20 % to 100 % of I _{max} Rated current range : 20 % to 50 % of I _{max} I _{max} = amplifier current rating
Analog current limitation input	0 V to 10 V, resolution = 12 bits 100 % to 0 % of the Maximum current value Maximum current available if not connected
Analog speed command input	±10 V, standard resolution = 12 bits Resolution = 16 bits optional
Motor accel/decel ramp range	From 0 to 30 s between zero speed and max. speed
Speed regulator P, PI or PI ²	Sampling period = 0,5 ms Anti-wind-up system of the integrator Adjustable digital gains Antiresonance filter
Speed loop bandwidth	Cut-off frequency for 45° phase shift Selectable : 50 Hz, 75 Hz or 100 Hz (see Note 1) ¹
Speed range	2048 : 1 with 12 bit input command 32768 : 1 with 16 bit input command
Max. motor speed	Adjustable from 100 rpm to 25000 rpm (see Note 2) ²
Hall sensors input	Selectable by jumpers : 120° or 60° HES type 5 V or 15 V supply voltage HES sequence error detection

¹ Note 1 :

The maximum speed loop bandwidth value not only depends on the amplifier specification but also on the feedback encoder resolution and the motor mechanical load. The lower the encoder resolution, the lower the servo loop gains and the servo loop bandwidth, to avoid any motor noise due to signal quantization effect. The mechanical load backlashes and elasticity can also limit the servo loop gains and bandwidth to avoid mechanical resonances. The optimal servo loop gain value for a given application can be automatically calculated by using the amplifier Auto-tuning procedure.

² Note 2 :

The Max. motor speed value not only depends on the motor specification but also on the encoder specification. Both following conditions must be answered for taking into account the maximum encoder pulse frequency value :

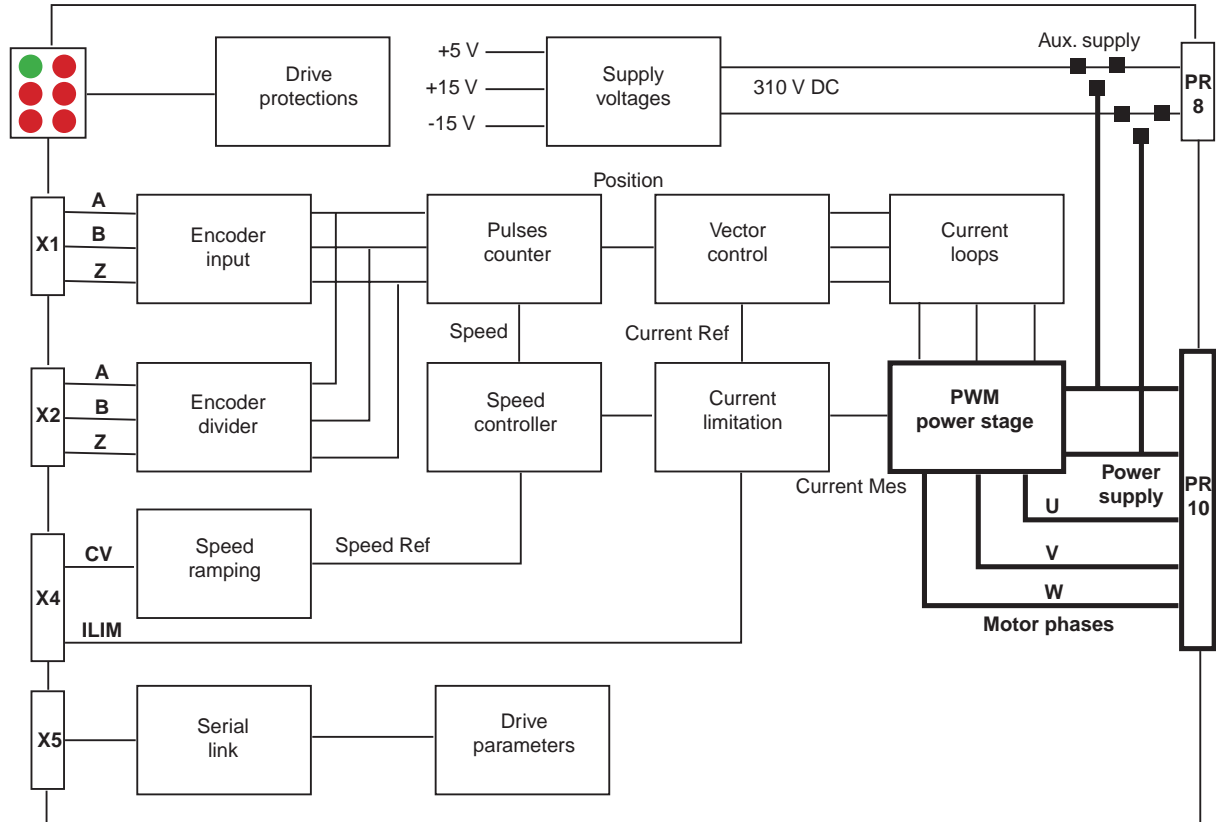
Max. motor speed (rpm) < 60 x 10⁶ / Number of encoder pulses per revolution

Max. motor speed (rpm) < 60 x Encoder pulse frequency limit (Hz) / Number of encoder pulses per revolution. For example with the ROD426 (Heidenhain) series encoder, the pulse frequency limit value is 300 KHz. So, a motor equipped with a ROD426 encoder having a resolution of 5000 ppr cannot exceed 3600 rpm.

Encoder input	<p>Selectable by jumpers :</p> <p>Quadrature TTL A & B with Z marker pulse RS 422 line receiver maximum pulses frequency: 500kHz Resolution: 500 to 10⁶ ppr (as from EPROM version 7.1C)</p> <p>Incremental Sin/Cos encoder Heidenhain 1 Vcc Sin/Cos type or compatible Maximum signal frequency: 500 kHz Resolution: 10³ to 10⁶ ppr</p> <p>Absolute single turn Sin/Cos encoder Heidenhain ERN 1085 or compatible resolution: 2048 ppr</p>
Encoder output	<p>Quadrature TTL A & B with Z marker pulse RS 422 line driver Programmable encoder division ratio output resolution / input resolution : 1, 1/2, 1/4, 1/8</p>
Logic inputs	<p>Optoisolated inputs, positive logic, response time = 0.5 ms:</p> <ul style="list-style-type: none"> •Enable/Disable: ENABLE •Limit switch +: FC+ •Limit switch -: FC- •Current command: CI •Stop & Phasing command: CV0 Amplifier fault reset: RESET
Logic outputs	<p>Relay contact Umax = 50 V, Imax = 100 mA, Pmax = 10 W</p> <ul style="list-style-type: none"> • "Power ready": closed if power OK • "Amp ready": closed if amplifier OK • "Phasing OK": closed if motor phasing OK (incremental encoder without HES) • "Idyn": open if I²t warning threshold is reached
Monitor outputs	<p>2 channels ANout1 & ANout2 +/-10 V full scale, 12 bit resolution Programmable output signals on the digitizing oscilloscope Channel 1 and Channel 2 : current ref (IDC), current mes (ID,IQ,IMES,I2t), speed ref (CV), speed mes (GT)</p>
Error display	LEDs on front panel and diagnostic via serial link
Parameter setting	Serial link RS232 in standard or RS422 optional
Automatic functions	<p>Motor parameters adjustment (Auto-phasing) Regulator gains adjustment (Auto-tuning) Offset compensation on analog input CV</p>
Altitude	1000 m
Moisture	<p>< 50 % at 40°C and < 90 % at 20°C no condensation (EN 60204.1 standard)</p>
Cooling	Natural convection or forced air, according to the rated current (see current tables, chapter 2, § 1.1 and 1.2)

2 - BLOCK DIAGRAM

The SMT-BD2 servo module block diagram is presented below.



The PR8 and PR10 connectors are not accessible for direct wiring; they are plugged on the BM20A single-axis rack or on the multiaxes BF rack according to the SMT-BD2 amplifier housing ([see chapter 3](#)).

3 - MAIN PROTECTIONS

3.1-DISPLAYED PROTECTIONS

PROTECTION	ERROR DISPLAY	LED*
Amplifier rated current overload . blinking display = I^2t warning threshold is reached (Idyn output) . continuous display = I^2t fault (amplifier inhibited in fusing mode)	I^2t	⊗ ● ● ●
Encoder cable interruption	Encoder	● ⊗ ● ●
Encoder pulses counting error	Counting	⊗ ⊗ ● ⊗
Power stage failure: . power supply overvoltage . internal overcurrent protection . short-circuit between phases . amplifier overtemperature (220/04 to 220/60 current ratings and 400 VAC amplifier range)	Power stage	⊗ ⊗ ● ●
Amplifier overtemperature (only 220/70 and 220/100 current rating amplifiers)	°C Amp	⊗ ● ⊗ ●
Power supply undervoltage	Undervolt.	● ⊗ ⊗ ●
Motor overtemperature	°C Motor	⊗ ⊗ ⊗ ●
Hall Effect Sensors or Sin/Cos commutation channels error	HES	● ● ⊗ ●
Analog to Digital Conversion error	ADC	⊗ ● ● ⊗
Speed following error	Tracking	● ● ● ⊗
Fault of the amplifier parameter storage	EEPROM	⊗ ● ⊗ ⊗
Amplifier automatic procedure: . blinking display = procedure operating . continuous display = operating error	Busy	⊗ ⊗ ⊗ ⊗

* ● = LED is unlit ⊗ = LED is lit.

All these faults are memory stored in the amplifier except for the "Undervolt." fault.

The reset of a stored fault can be made:

- by means of the RESET function in the **Visual Drive Setup** software
- via the fault RESET input (pin 13 of the X4 connector)
- by switching off the amplifier power supply.

3.2 - FUSE PROTECTION

3.2.1 - Fuse protection for the 220 VAC amplifier version

F1 : Control of the average DC current of the power board supply (see [Hardware adjustments in chapter 5, § 1](#)).

F2 : Control of the average DC current of the logic board supply (see [Hardware adjustments in chapter 5, § 1](#)).

AMPLIFIER TYPE	F1 Power	F2 Logic
SMTBD2-220/04 to 12	10 AT	1 A
SMTBD2-220/17 and 30	15 AT	1 A
SMTBD2-220/45	20 AT	1 A
SMTBD2-220/60	20 AT	1 A
SMTBD2-220/70	-	1 A
SMTBD2-220/100	-	1 A

3.2.2 - Fuse protection for the 400 VAC amplifier version

F2 : Control of the average DC current of the logic board supply (see [Hardware adjustments in chapter 5, § 1](#)).

AMPLIFIER TYPE	F2 Logic
SMT-BD2 - 400/15	1 A
SMT-BD2 - 400/30	1 A
SMT-BD2 - 400/45	1 A
SMT-BD2 - 400/60	1 A
SMT-BD2 - 400/100	1 A

Chapter 3 - Inputs - Outputs

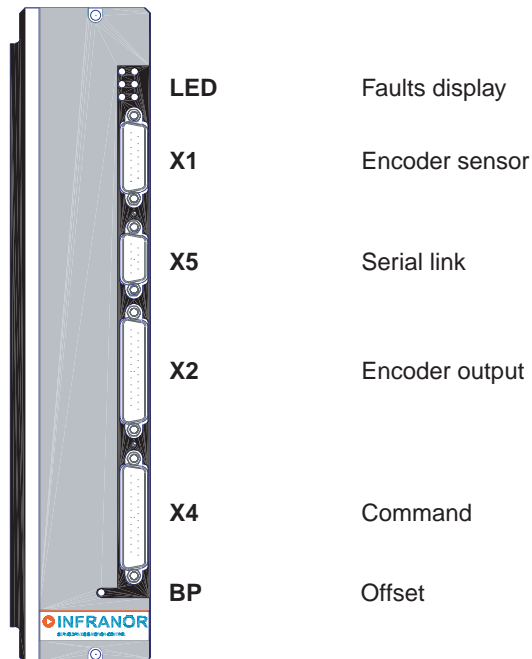
1 - CONNECTORS LOCATION

1.1 - RACK CONNECTORS

For the 400 VAC amplifier version, see [BF-400 RACK manual](#).

For the 220 VAC amplifier version, see [SMTB.M 20 A SINGLE-AXIS RACK manual](#) or [BF RACK manual](#).

1.2 - AMPLIFIER CONNECTORS



2 - X5 SERIAL LINK CONNECTOR (Sub D 9 points male)

PIN	FUNCTION	REMARKS
5	0 Volt	GND (shield connection if no "360°" connection possible on the connector)
3	TXD	Transmit data RS-232
2	RXD	Receive data RS-232
6	TXH	Transmit data RS-422
7	TXL	Transmit data RS-422
8	RXL	Receive data RS-422
9	RXH	Receive data RS-422

3 - X1 ENCODER FEEDBACK CONNECTOR (Sub D 15 points female)

3.1 – X1 CONNECTOR FOR TTL INCREMENTAL ENCODER CONFIGURATION

The "TTL incremental encoder" configuration is selected according to the following COM and COD jumpers setting (see chapter 5, section 1: Hardware adjustments).

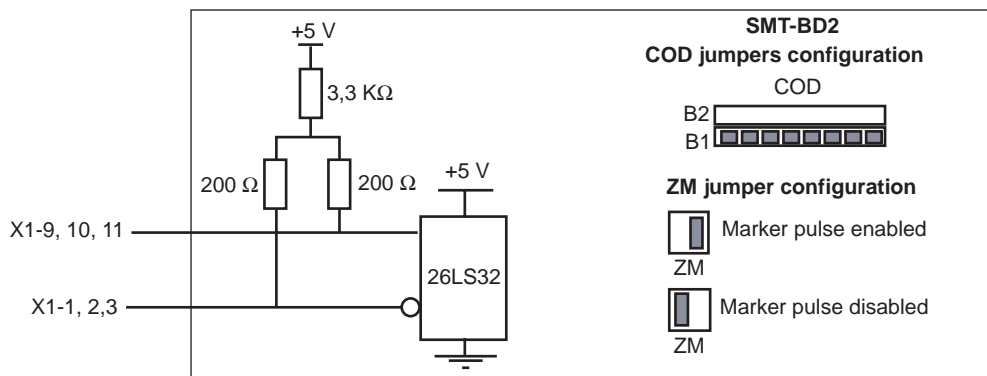


A wrong jumper configuration may damage the encoder and amplifier electronics.

The corresponding X1 connector pin function is described below.

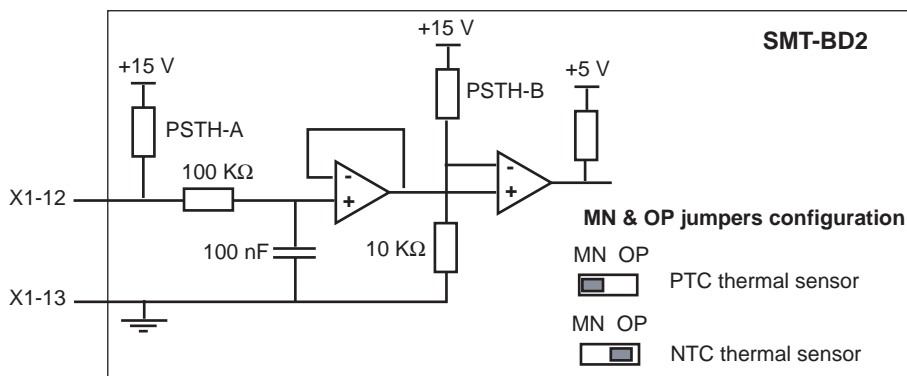
PIN	FUNCTION	REMARKS
1	Marker Z/	Differential input of the encoder marker pulse Z/
9	Marker Z	Differential input of the encoder marker pulse Z
2	Channel A/	Differential input of the encoder channel A/
10	Channel A	Differential input of the encoder channel A
3	Channel B/	Differential input of the encoder channel B/
11	Channel B	Differential input of the encoder channel B
5	+5V	Encoder supply voltage (400 mA max. current)
4	GND	Encoder supply GND
12	TC	Motor thermal sensor input (10 mA max. load current)
13	GND	Motor thermal sensor GND
6,7,8	reserved	
14,15	reserved	

Encoder input specification



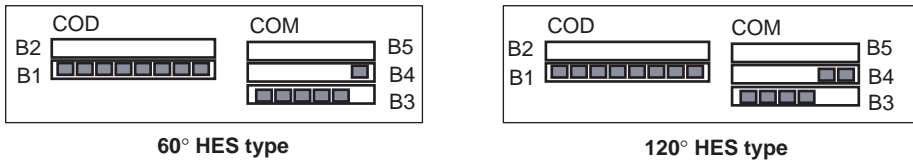
Recommended driver: 26LS31

Thermal sensor input specification



3.2 – X1 CONNECTOR FOR TTL INCREMENTAL ENCODER & HES CONFIGURATION

The “TTL incremental encoder & HES” configuration is selected according to the following COM and COD jumpers setting (see chapter 5, section 1: Hardware adjustments).

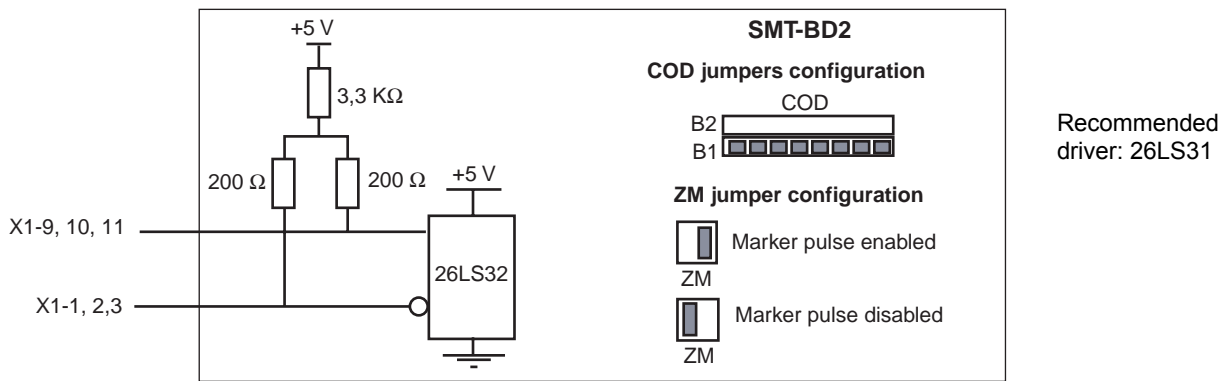


A wrong jumper configuration may damage the encoder and amplifier electronics.

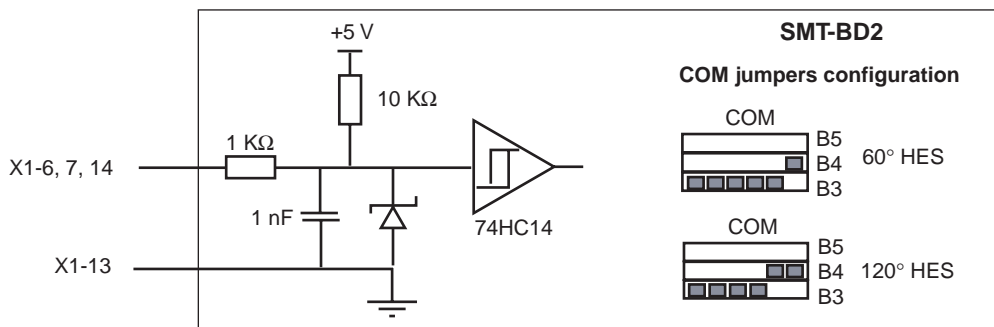
The corresponding X1 connector pin function is described below.

PIN	FUNCTION	REMARKS
1	Marker Z/	Differential input of the encoder marker pulse Z/
9	Marker Z	Differential input of the encoder marker pulse Z
2	Channel A/	Differential input of the encoder channel A/
10	Channel A	Differential input of the encoder channel A
3	Channel B/	Differential input of the encoder channel B/
11	Channel B	Differential input of the encoder channel B
5	+5V	Encoder supply voltage (400 mA max. current)
4	GND	Encoder supply GND
14	HALL U	Hall sensor input signal phase U
6	HALL V	Hall sensor input signal phase V
7	HALL W	Hall sensor input signal phase W
15	+15V	Hall sensors supply voltage (50 mA max. current)
12	TC	Motor thermal sensor input (10 mA max. load current)
13	GND	Hall sensors/Thermal sensor GND
8	reserved	

Encoder input specification



Specification of the Hall sensors input



3.3 – X1 CONNECTOR FOR ABSOLUTE SINGLE TURN Sin/COS ENCODER CONFIGURATION

The “Absolute single turn Sin/Cos encoder ” configuration (Heidenhain ERN 1085 or compatible) is selected according to the following COM and COD jumpers setting (see chapter 5, section 1: Hardware adjustments).

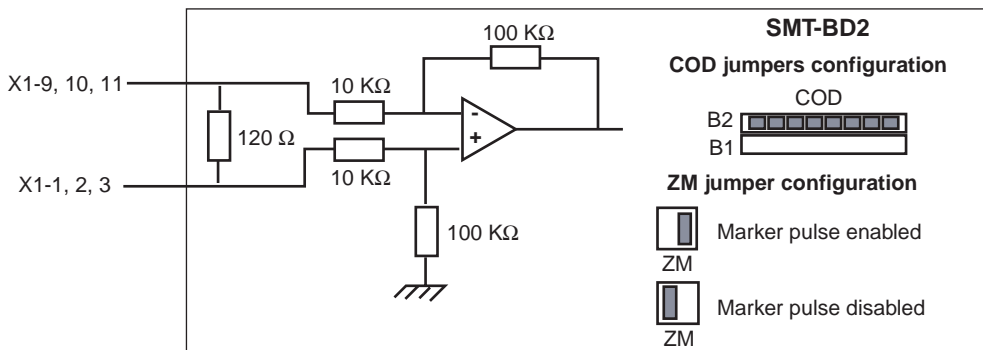


A wrong jumper configuration may damage the encoder and amplifier electronics.

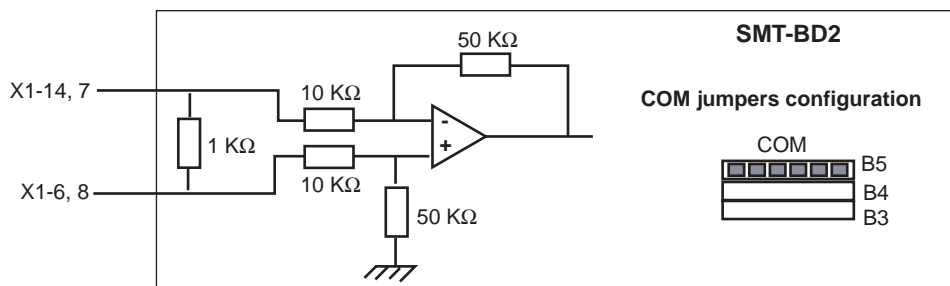
The corresponding X1 connector pin function description is given below.

PIN	FUNCTION	REMARKS
1	Reference R/	Differential input of the Sin/Cos encoder reference pulse R/
9	Reference R	Differential input of the Sin/Cos encoder reference pulse R
2	Channel A/	Differential input of the Sin/Cos encoder channel A/
10	Channel A	Differential input of the Sin/Cos encoder channel A
3	Channel B/	Differential input of the Sin/Cos encoder channel B/
11	Channel B	Differential input of the Sin/Cos encoder channel B
6	Channel C/	Differential input of the Sin/Cos encoder channel C/
14	Channel C	Differential input of the Sin/Cos encoder channel C
8	Channel D/	Differential input of the Sin/Cos encoder channel D/
7	Channel D	Differential input of the Sin/Cos encoder channel D
5	+5V	Sin/Cos encoder supply voltage (400 mA max. current)
4	GND	Sin/Cos encoder supply GND
12	TC	Motor thermal sensor input (10 mA max. load current)
13	GND	Motor thermal sensor GND
15	reserved	

Specification of the Sin/Cos encoder channels



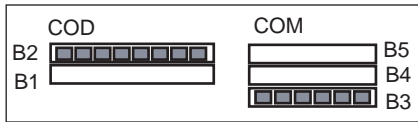
Specification of the Sin/Cos commutation channels



3.4 - X1 CONNECTOR FOR OTHER SIN/COS ENCODER CONFIGURATIONS

3.4.1 – X1 CONNECTOR FOR INCREMENTAL SIN/COS ENCODER CONFIGURATION

The “ Incremental Sin/Cos encoder ” configuration (Heidenhain 1Vcc Sin/Cos encoder or compatible) is selected according to the following COM and COD jumpers setting (see chapter 5, section 1: Hardware adjustments).



A wrong jumper configuration may damage the encoder and amplifier electronics.

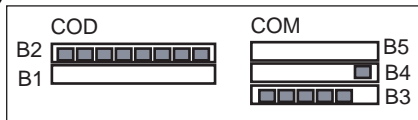
The corresponding X1 connector pin function description is given below.

PIN	FUNCTION	REMARKS
1	Reference R/	Differential input of the Sin/Cos encoder reference pulse R/
9	Reference R	Differential input of the Sin/Cos encoder reference pulse R
2	Channel A/	Differential input of the Sin/Cos encoder channel A/
10	Channel A	Differential input of the Sin/Cos encoder channel A
3	Channel B/	Differential input of the Sin/Cos encoder channel B/
11	Channel B	Differential input of the Sin/Cos encoder channel B
5	+5V	Sin/Cos encoder supply voltage (400 mA max. current)
4	GND	Sin/Cos encoder supply GND
12	TC	Motor thermal sensor input (10 mA max. load current)
13	GND	Motor thermal sensor GND
6,7,8	Reserved	
14,15	Reserved	

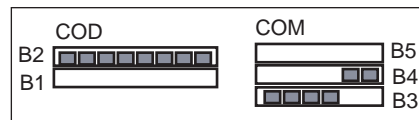
The Sin/Cos channels specifications are given in section 3.3 of this chapter.

3.4.2 – X1 CONNECTOR FOR INCREMENTAL SIN/COS ENCODER & HES CONFIGURATION

The “ Incremental Sin/Cos encoder & HES ” configuration (Heidenhain 1Vcc Sin/Cos encoder or compatible) is selected according to the following COM and COD jumper setting (see chapter 5, section 1: Hardware adjustments).



60° HES type



120° HES type



A wrong jumper configuration may damage the encoder and amplifier electronics.

The corresponding X1 connector pin function description is given below.

PIN	FUNCTION	REMARKS
1	Reference R/	Differential input of the Sin/Cos encoder reference pulse R/
9	Reference R	Differential input of the Sin/Cos encoder reference pulse R
2	Channel A/	Differential input of the Sin/Cos encoder channel A/
10	Channel A	Differential input of the Sin/Cos encoder channel A
3	Channel B/	Differential input of the Sin/Cos encoder channel B/
11	Channel B	Differential input of the Sin/Cos encoder channel B
5	+5V	Sin/Cos encoder supply voltage (400 mA max. current)
4	GND	Sin/Cos encoder supply GND
14	HALL U	Hall sensor input signal phase U
6	HALL V	Hall sensor input signal phase V
7	HALL W	Hall sensor input signal phase W
15	+15V	Hall sensors supply voltage (50 mA max. current)
12	TC	Motor thermal sensor input (10 mA max. load current)
13	GND	Motor thermal sensor GND
8	Reserved	

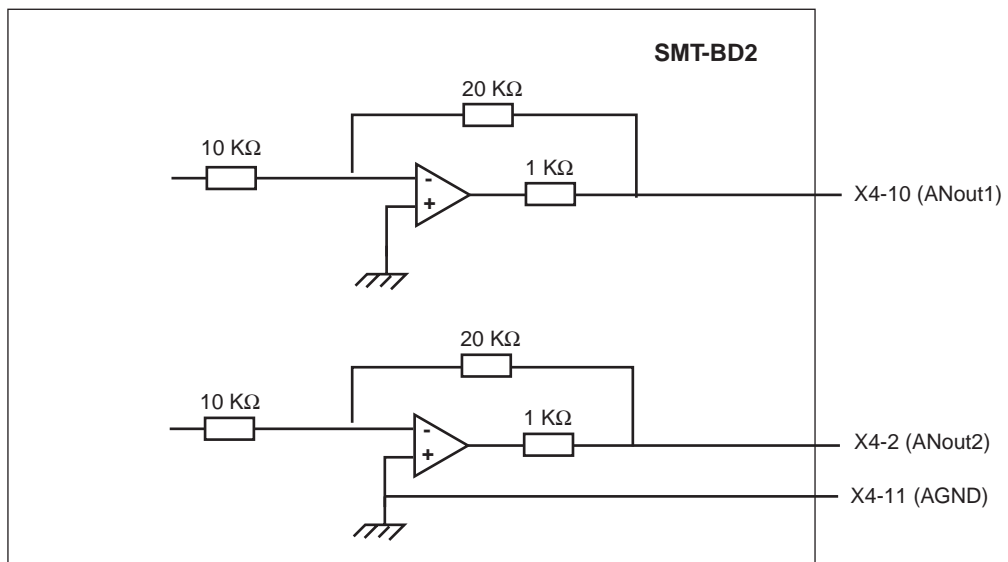
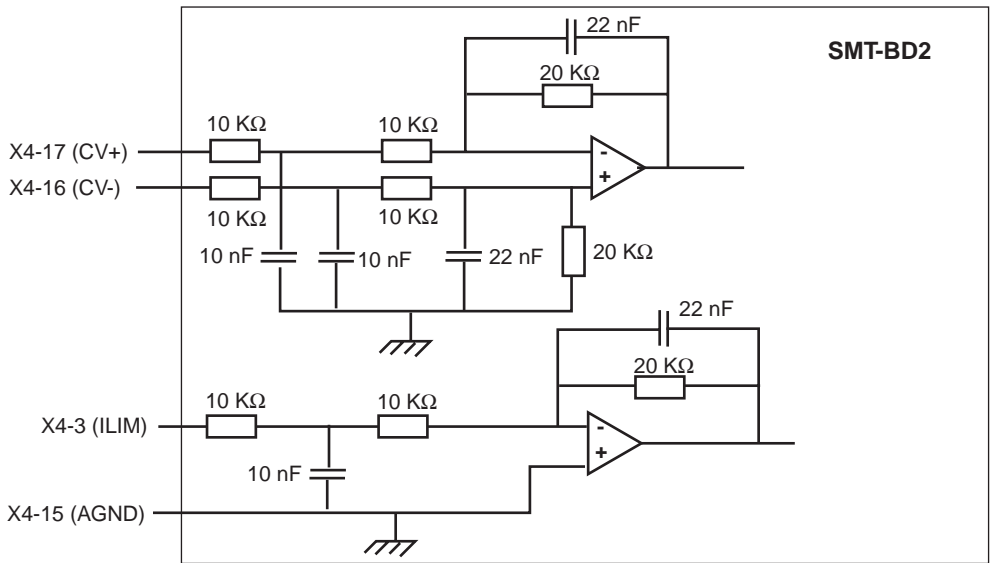
The Sin/Cos channels specifications are given in section 3.3 of this chapter.

The Hall sensor inputs specifications are given in section 3.2 of this chapter.

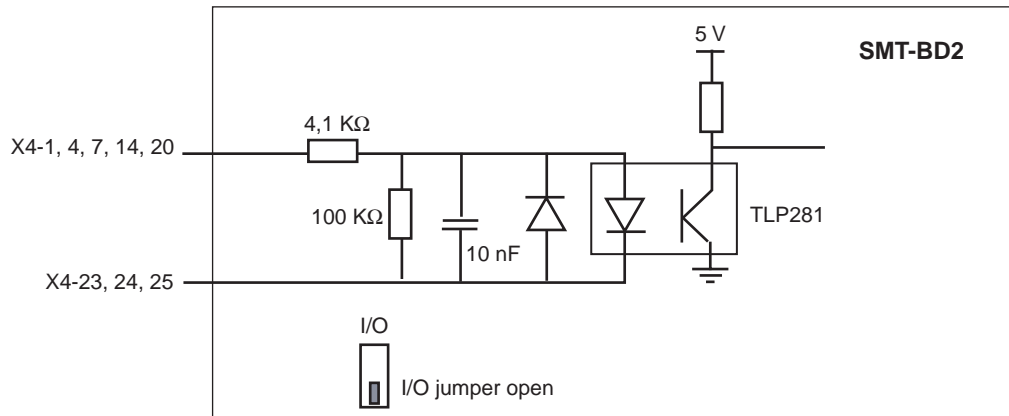
4 - X4 COMMAND CONNECTOR (Sub D 25 points male)

Pin	Function	I / O	REMARKS
1	Limit switch +	I	Optoisolated input (I/O jumper open), positive logic (5V to 24V)
14	Limit switch -	I	Optoisolated input (I/O jumper open), positive logic (5V to 24V)
4	Current command CI	I	Optoisolated input (I/O jumper open), positive logic (5V to 24V)
7	Stop&Phasing command CV0	I	Optoisolated input (I/O jumper open), positive logic (5V to 24V)
20	Enable/Disable	I	Optoisolated input (I/O jumper open), positive logic (5V to 24V)
23,24,25	0 Volt of optoisolated input	I	Optoisolated reference (I/O jumper open)
13	RESET	I	Amplifier reset via 0 V (contact between 13 and 12)
12	0 Volt of RESET input	I	
3	Current limitation input	I	Current limitation 100 % to 0 % of the Maximum current value for 0 V to 10 V (Maximum current available if not connected)
15	0 Volt analog inputs	I	
17	Input command CV +	I	± 10 V speed input command with CI input inactive (Maximum speed value for 10 V) ± 10 V current input command with CI input active (full amplifier current rating I _{max} for 10 V)
16	Input command CV -	I	
10	ANout1 monitor	O	± 10 V; resolution: 12 bits; load: 10 mA ± 10 V; resolution: 12 bits; load: 10 mA Programmable output signals on the digitizing oscilloscope Channel 1 and Channel 2: current ref (IDC), current mes (ID, IQ, IMES, I2t), speed ref (CV), speed mes (GT)
2	ANout2 monitor	O	
11	0 Volt analog outputs		
18,19	Amplifier ready	O	Relay contact: closed if amplifier OK P _{max} = 10 W with U _{max} = 50 V or I _{max} = 100 mA Overvoltage pulses protection by bidirectional TRANSIL
5,6	Phasing OK	O	Relay contact: closed if motor phasing OK (in motor phasing configuration without HES) P _{max} = 10 W with U _{max} = 50 V or I _{max} = 100 mA Overvoltage pulses protection by bidirectional TRANSIL
8,9	Idyn warning	O	Relay contact: open if Idyn warning threshold is reached P _{max} = 10 W with U _{max} = 50 V or I _{max} = 100 mA Overvoltage pulses protection by bidirectional TRANSIL
21	+ 15 V	O	47 Ohms output impedance, 50 mA max. output current
22	- 15 V	O	47 Ohms output impedance, 50 mA max. output current

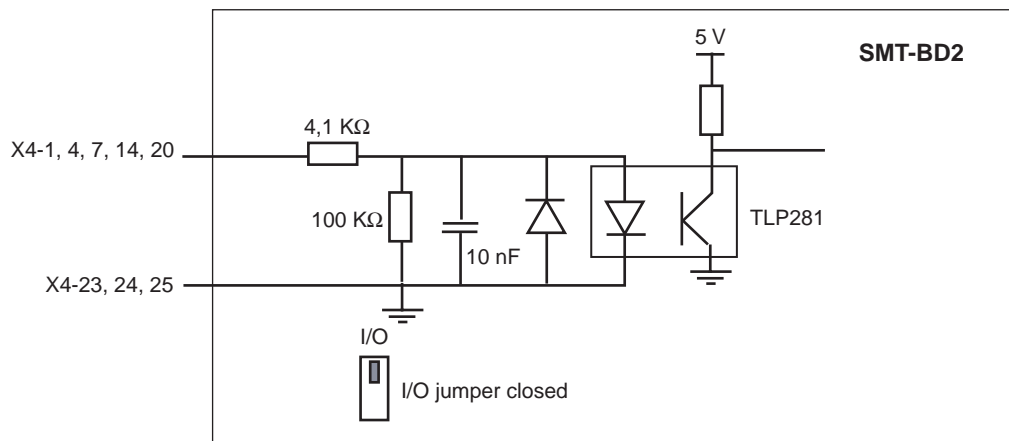
4.1 - SPECIFICATION OF THE ANALOG INPUTS / OUTPUTS



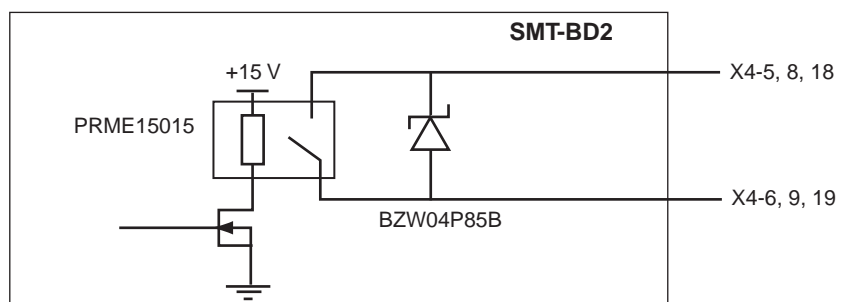
4.2 - SPECIFICATION OF THE LOGIC INPUTS / OUTPUTS



When the I/O jumper is open, the 0 V of the optoisolated inputs (X4 pins 23,24,25) is not connected to the 0 V of the SMT-BD2 amplifier module (X4, pin 12).



When the I/O jumper is closed, the 0 V of the optoisolated inputs (X4, pins 23, 24, 25) is connected to the 0 V of the SMT-BD2 amplifier module (X4, pin 12).

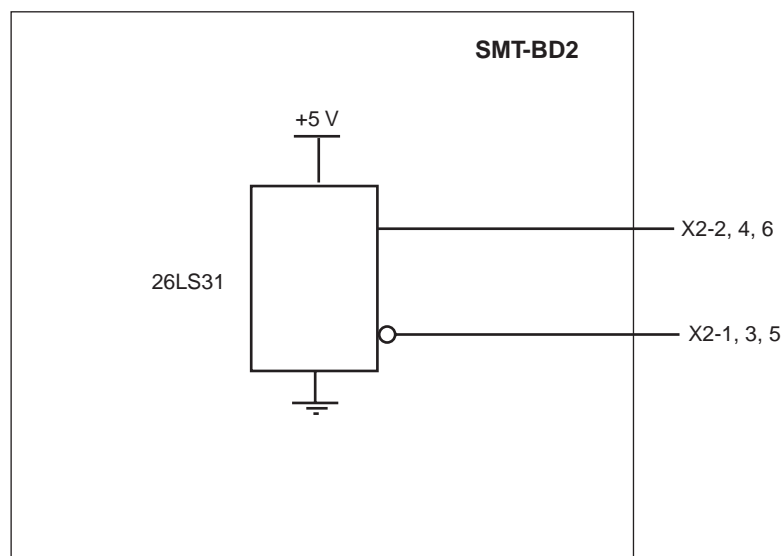


5 - X2 POSITION OUTPUT CONNECTOR (Sub D 25 points female)

PIN	FUNCTION	I / O	REMARKS
1	Marker Z/	O	Differential output of the encoder marker pulse (5 V, 20 mA max.)
2	Marker Z	O	Differential output of the encoder marker pulse
3	Channel A/	O	Differential output of the encoder channel A/ (5 V, 20 mA max.)
4	Channel A	O	Differential output of the encoder channel A
5	Channel B/	O	Differential output of the encoder channel B/ (5 V, 20 mA max.)
6	Channel B	O	Differential output of the encoder channel B
7 & 25	0 V	O	
8 to 24	reserved		

The programmable encoder output **Division ratio** (Output resolution / Input resolution) is only valid for the A and B channels. The Marker Z channel is not modified by this parameter value.

SPECIFICATION OF THE TTL ENCODER OUTPUT



Recommended receiver: 26LS32.

Chapter 4 - Connections

1 - CONNECTION DIAGRAMS

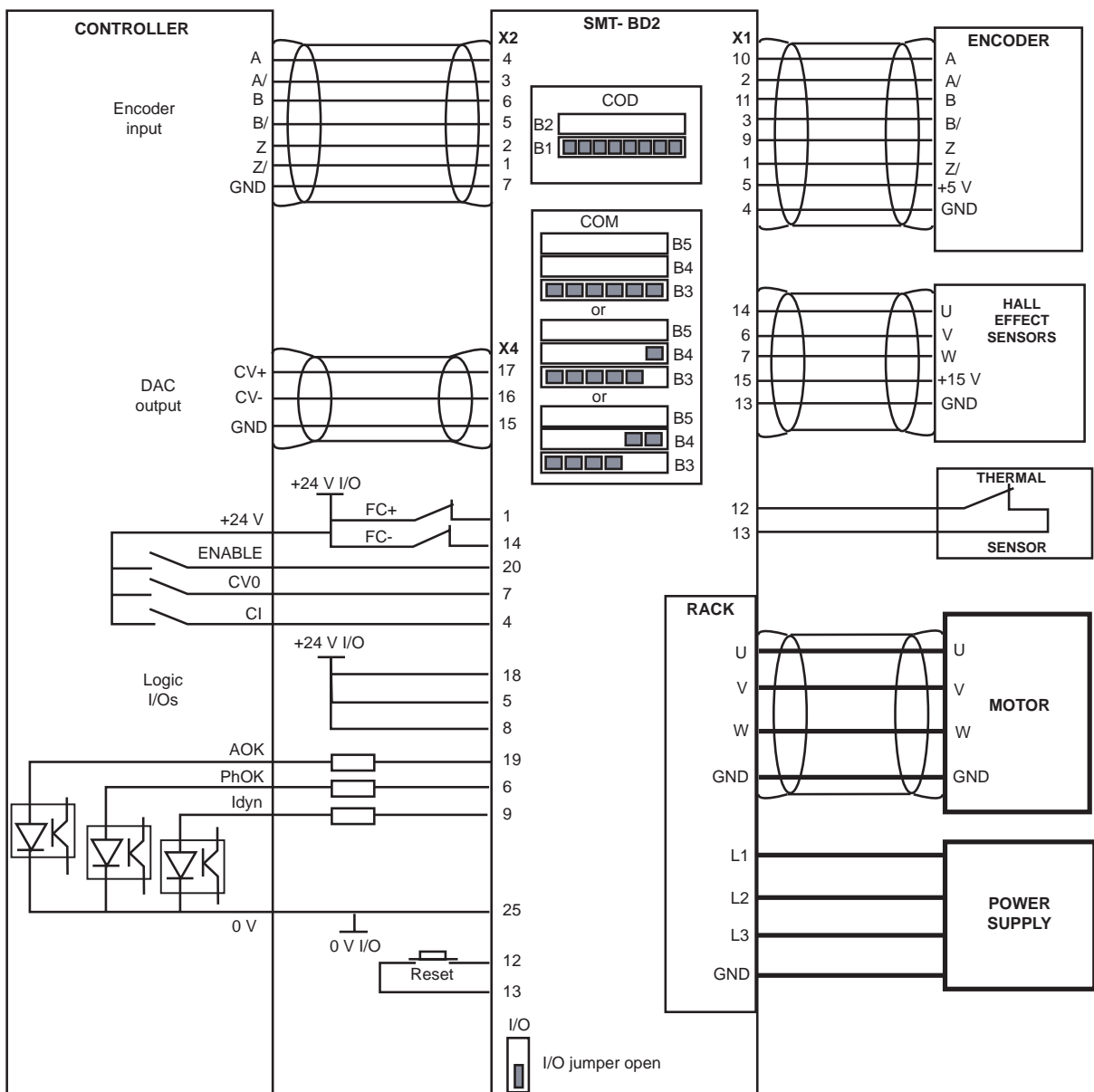
1.1 - RACK POWER SUPPLY AND MOTOR CONNECTION

For the 400 VAC amplifier version, see **BF-400 RACK** manual.

For the 220 VAC amplifier version, see **BM20A SINGLE-AXIS RACK** manual or **BF RACK** manual.

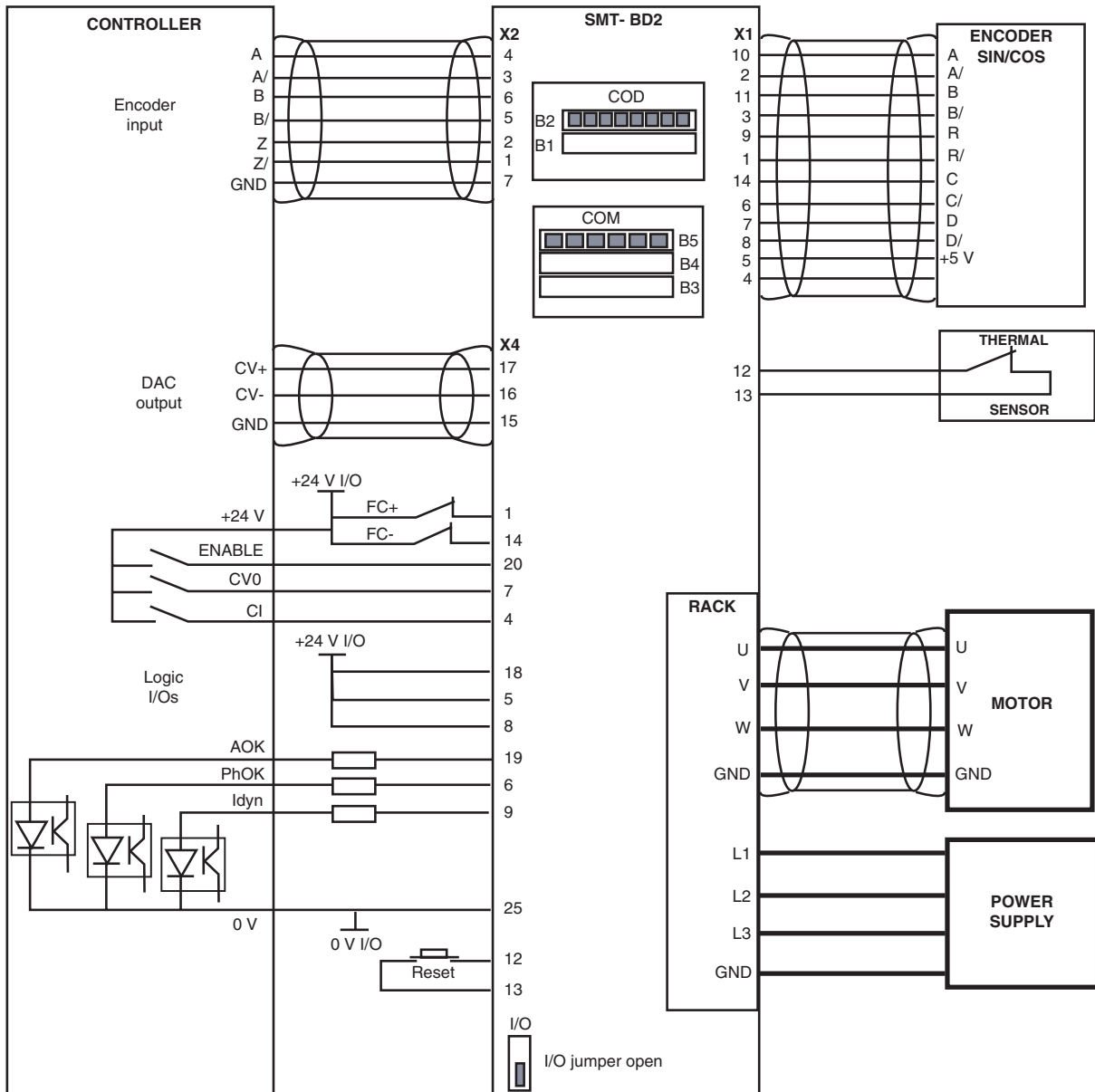
1.2 - AMPLIFIER I/O CONNECTIONS

1.2.1 - Amplifier connections with TTL encoder & HES motor feedback



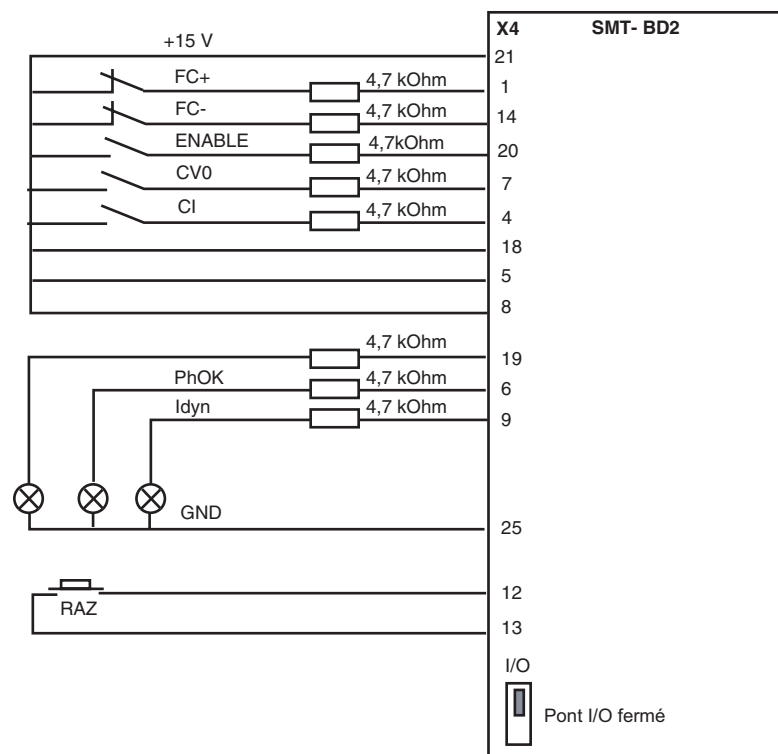
The I/O jumper must be open for getting the X4 connector I/Os optoisolation : the I/O 0 V (X4, pins 23, 24, 25) is disconnected from the 0 V of the SMT-BD2 amplifier module.

1.2.2 - Amplifier connections with Absolute single turn Sin/Cos encoder feedback



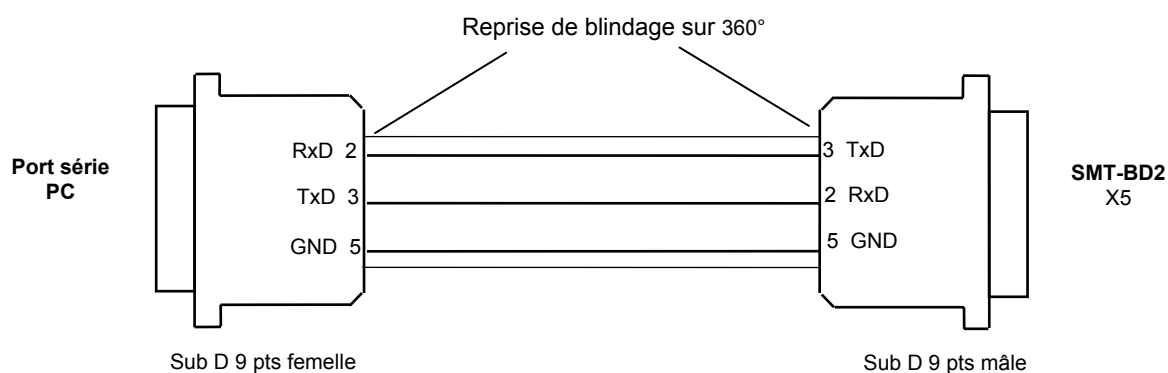
The I/O jumper must be open for getting the X4 connector I/Os optoisolation : the I/O 0 V (X4, pins 23, 24, 25) is disconnected from the 0 V of the SMT-BD2 amplifier module.

1.2.3 – CONNEXION DES E/S DU VARIATEUR EN UTILISANT LA TENSION D’ALIMENTATION +15 V SUR LE CONNECTEUR X4



Le pont des I/O doit être fermé pour que le 0 V des E/S (X4, pins 23, 24, 25) soit connecté au 0 V du module variateur SMT-BD2.

1.3 – CONNEXION DE LA LIAISON SERIE RS-232



2 - WIRING (according to CEI 801 and EN 55011 standards)

2.1 - GND WIRING AND GROUNDING

The reference potential is the **earth (ground)**. Motors and sensors (encoder + HES) are grounded via their housing. If a potential reference is existing, like a main chassis or a cabinet, with a low impedance between the various elements, it should be used to connect ALL references to it and also connect this reference to the earth (ground).

Long reference potential connections are suitable **ONLY** if these connections have an impedance $< 0,1 \Omega$. Cables with low potential should **NEVER** run in the proximity of power lines. **Each conductor cable** (carrying a potential) must be **shielded**. Several wires in the **same sleeve** must be **twisted** and **shielded**.

According to the **CEI 801 standard**, the connectors must be metallic or metal plated and must have a **360° shield connection**.

2.2 - MOTOR AND SENSORS CABLES

Cable ends should have a metallic collar allowing a 360° shield connection.

Motor cables must be shielded to avoid common mode effects.

Encoder and HES cable must also be shielded.

2.3 - INPUT COMMAND AND SERIAL LINK CABLES

The analog input command signal CV requires a pair twisted and shielded cable. The shield must have a "360°" connection via metallic collars at both ends. If the shield is connected by means of a pig tail, it must be connected at one end to a 0 Volt pin of X4 on the amplifier side with a connection as short as possible.

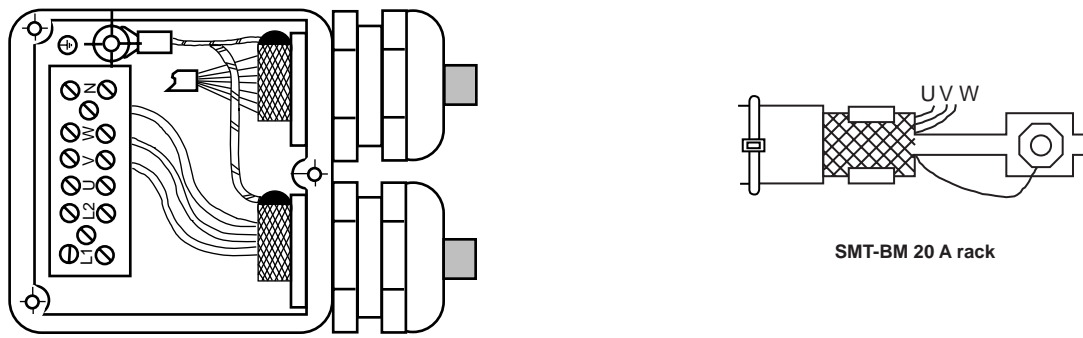
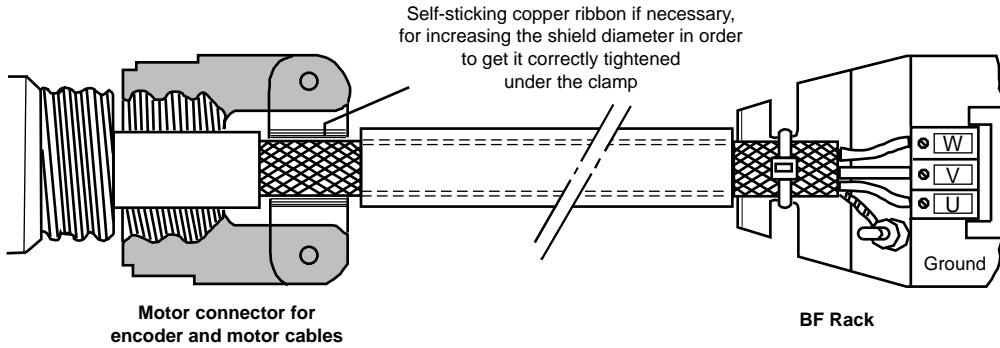
The input command (CV) wiring must be made according to the polarity between the controller and the amplifier (CV on "diff high" of the controller). The logic 0 Volt is directly connected to the amplifier housing. The connection continuity is ensured by the fastening screws on the front panels. **The amplifier 0 Volt and the controller 0 Volt MUST be connected by means of a wire. The shield MUST NEVER be used as a conductor of the 0 Volt potential.**

The serial link cable must also be shielded according to the above mentioned shielding recommendations.

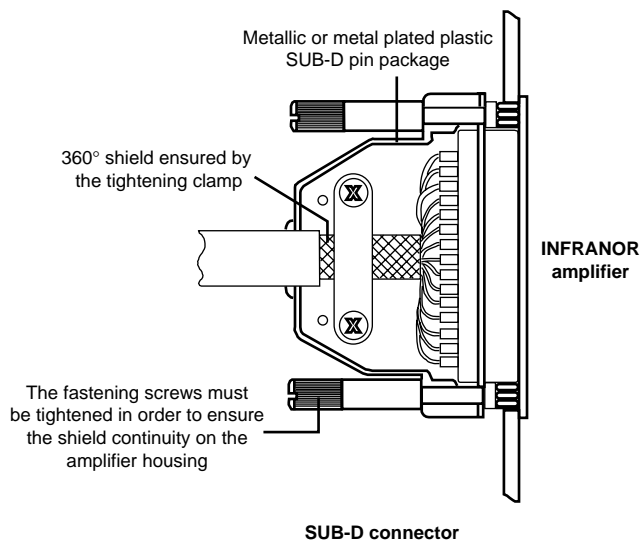
3 - 360° SHIELD ON THE CONNECTORS

RULE :

The shield must never be interrupted or corrupted over the whole cable length.



The cable can be soldered on the shield because the connector box is metallic. This solution does not exactly meet the EMC requirements but it is acceptable.



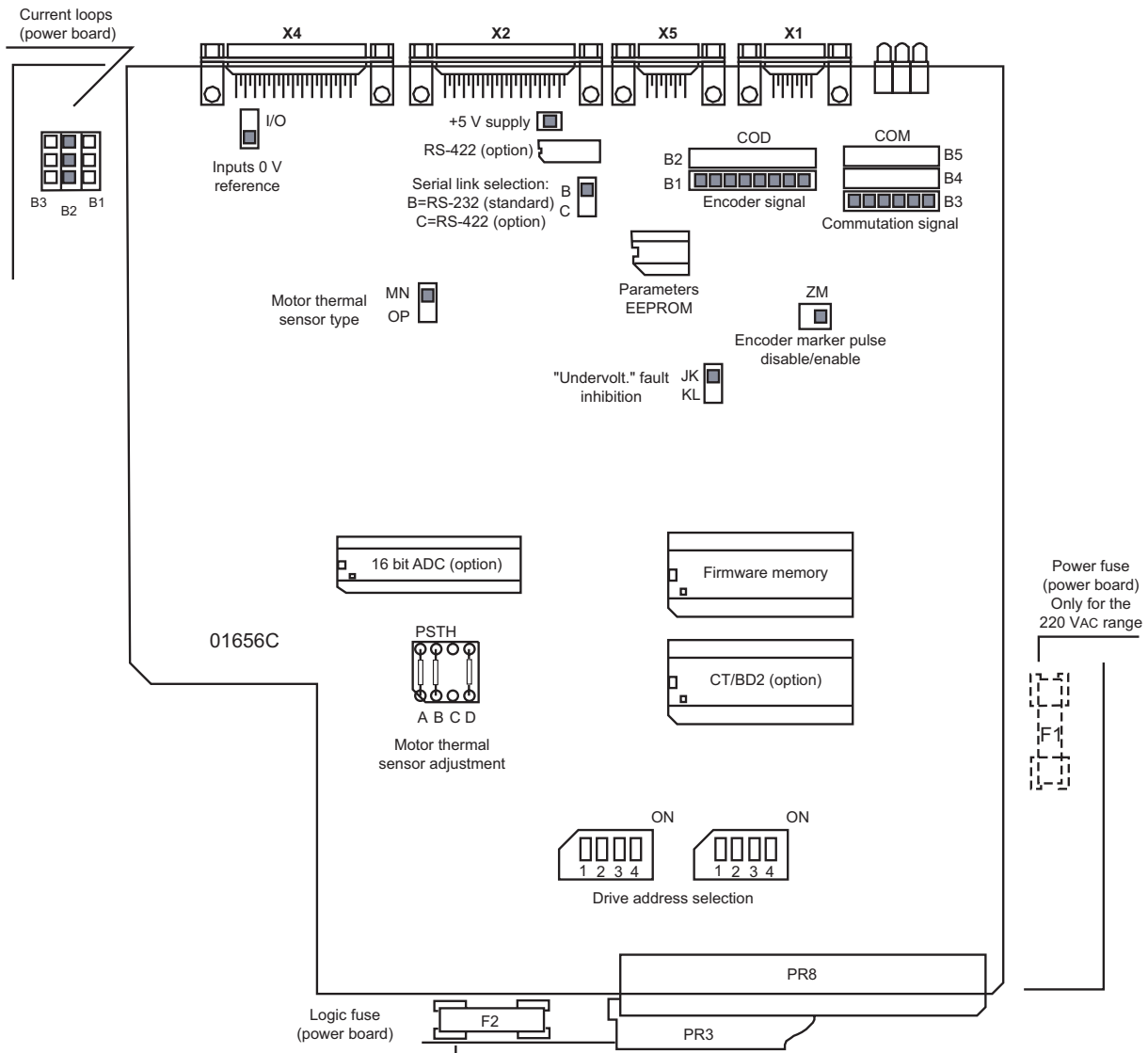
NOTE :

When the 360° shield is made by means of a clamp it is not necessary to additionally connect a wire on the shield connection pin of the SUB-D connector.

Chapter 5 - Adjustable functions

1 - HARDWARE ADJUSTMENTS

All the hardware adjustments of the SMT-BD2 amplifier module are presented on the following diagrams.

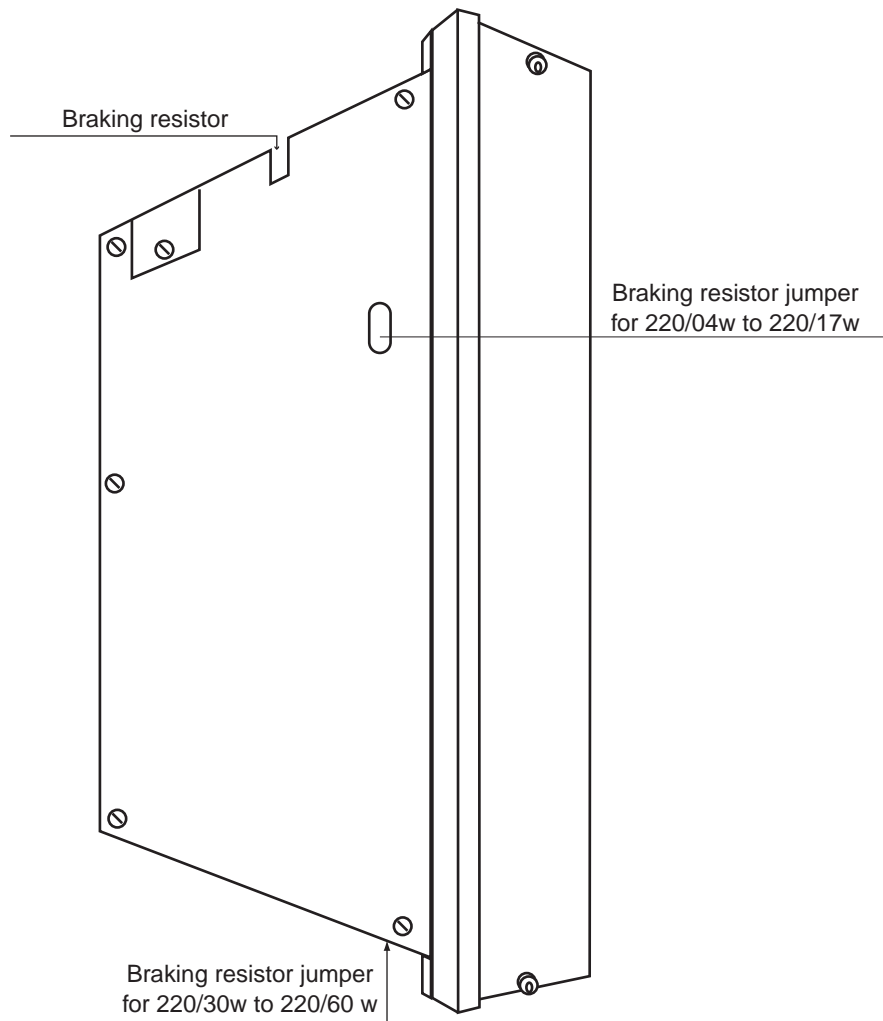


For amplifier types 220/04 to 220/100 and 400/15 to 400/100 VAC range



CAUTION !
For amplifier versions with 70 A and 100 A current ratings in 220 V and serial numbers lower than 260600, please contact INFRANOR.

BRAKING SYSTEM SOLUTION ON SMT-BD2-220/04w TO 220/60w



SMT-BM 20 A single-axis rack: Braking resistor jumper closed.
 BF-rack: Braking resistor jumper open.

NOTE: This braking resistor system selection is only available on « w » referenced amplifiers.

2 – ADJUSTABLE PARAMETERS

The SMT-BD2 serial link connector (X5) must be connected to the serial interface of a PC for the parameter setting operation. The **Visual Drive Setup** software, which is IBM-PC compatible with the WINDOWS® operating system, allows the clear display and easy modification of all amplifier parameters.

Please see Web site www.infranor.fr for downloading the **Visual Drive Setup** software.

Minimum requirements for the PC

Processor	:	Pentium
Operating system:	:	WINDOWS 95/98, WINDOWS NT
Graphics adapter	:	Windows compatible, colour SVGA with resolution 800x600 or 1024x768
Drives	:	3.5" disk drive hard disk with 6 MB free space
Main memory	:	at least 8 MB
Interface	:	One free serial interface (COM1, COM2, COM3 or COM4)

Chapter 6 - Commissioning



During the machine adjustments, some drive connection or parameter setting errors may involve dangerous axis movements. It is the user's responsibility to take all necessary steps in order to reduce the risk due to uncontrolled axis movements during the operator's presence in the concerned area.

1 - CHECKING THE AMPLIFIER CONFIGURATION

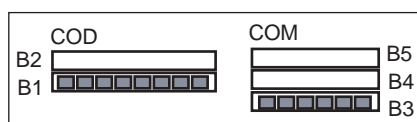
1.1 - STANDARD AMPLIFIER CONFIGURATION

The standard SMT-BD2 amplifier configuration is given below. See [chapter 5, section 1 "Hardware adjustments"](#) for the jumpers location.

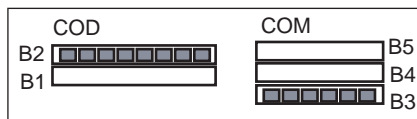
- * Inputs 0 V reference jumper I/O is open (optoisolated inputs)
- * Current loops adjustment jumpers in position B2 (medium gain)
- * Motor temperature sensor jumper in position MN (PTC sensor type)
- * Undervolt fault inhibition jumper in position JK ("Undervolt." fault enabled)
- * Serial link communication jumper in position B (RS-232 protocol)
- * Drive address selection jumpers in position OFF (address 0 selected)
- * Encoder signal jumpers COD in position B1 (TTL incremental encoder configuration)
- * Encoder marker pulse jumper in position ZM (encoder marker pulse enabled)
- * Commutation signal jumpers COM in position B3 (incremental encoder configuration without HES)

1.2 - ENCODER CONFIGURATION

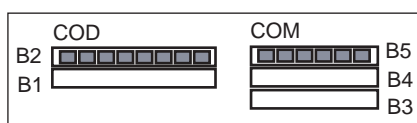
If the motor is equipped with a "TTL incremental encoder", select the following COD and COM jumpers setting.



If the motor is equipped with a "Sin/Cos incremental encoder", select the following COD and COM jumpers setting.

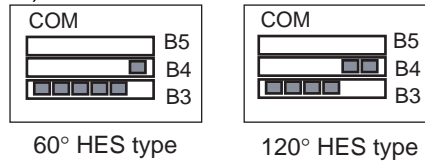


If the motor is equipped with an "Absolute single turn Sin/Cos encoder" (Heidenhain ERN 1085 or compatible), select the following COD and COM jumpers setting.

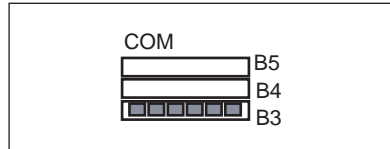


1.3 - HALL EFFECT SENSORS CONFIGURATION

If the motor is equipped with Hall Effect Sensors devices (HES), select the following COM jumpers setting according to the HES type (60° or 120°).



If the motor is not equipped with Hall Effect Sensors devices, the following COM jumpers setting must be selected. In this case a motor phasing procedure must be executed at each amplifier power up.



1.4 - MOTOR THERMAL SENSOR CONFIGURATION

Select the right MN or OP jumper setting according to the motor thermal sensor type (PTC or NTC).

1.4.1 - PTC thermal sensor

On motors equipped with a PTC thermal sensor (triggering on high impedance), the amplifier configuration is the following: MN jumper closed and OP jumper open. The triggering threshold adjustment for the PTC thermal sensor is made by means of the PSTH components, as described below : PSTH-D = 14,3 k Ω ; PSTH-B = 28 k Ω ; PSTH-A = 3 x RPTC (120°C) in k Ω . RPTC (120°C) = ohmic value of the PTC thermal sensor resistor at 120°C; the default adjustment is RPTC (120°C) # 3 k Ω with PSTH-A = 10 k Ω .

1.4.2 - NTC thermal sensor

On motors equipped with a NTC thermal sensor (triggering on low impedance), the amplifier configuration is the following: OP jumper closed and MN jumper open. The triggering threshold adjustment for the NTC thermal sensor is made by means of the PSTH components, as described below: PSTH-D = 14,3 k Ω ; PSTH-B = 28 k Ω ; PSTH-A = 3 x RNTC (120°C) in k Ω . RNTC (120°C) = ohmic value of the NTC thermal sensor resistor at 120°C; the default adjustment is RNTC (120°C) # 3 k Ω with PSTH-A = 10 k Ω .

1.5 - CURRENT LOOPS ADJUSTMENTS

1.5.1 - Current loops adjustments for the 400 VAC amplifier version

Select the right current loops jumpers setting (B1, B2 or B3 position) according to motor and amplifier specifications.

For the 400VAC version of the BL MAVILOR motor series, the current loops adjustments are made according to following selection table.

AMPLIFIER \ MOTOR	15 A	30 A	45 A	60 A	100 A
BL 113	B2				
BL 114	B2				
BL 115	B2	B1			
BL 141	B1	B1			
BL 142	B2	B1			
BL 143	B1	B1	B1		
BL 144	B1	B1	B1		
BL 191			B3	B3	B2
BL 192			B3	B3	B2

For other motors the adjustment of the current loops according to the **amplifier current rating** and to the **inductance between the motor terminals** is made as follows:

15 A and 30 A amplifier current ratings

Calculation of $G = 0.8 \times \text{Amplifier current rating (A)} \times \text{Inductance between phases (mH)}$,

If $G < 60$, current loop jumpers (x3) on **B3** position,

If $60 < G < 100$, current loop jumpers (x3) on **B2** position,

If $G > 100$, current loop jumpers (x3) on **B1** position.

45 A, 60 A and 100 A amplifier current ratings

Calculation of $G = 0.8 \times \text{Amplifier current rating (A)} \times \text{Inductance between phases (mH)}$,

If $G < 100$, current loop jumpers (x3) on **B3** position,

If $100 < G < 250$, current loop jumpers (x3) on **B2** position,

If $G > 250$, current loop jumpers (x3) on **B1** position.

1.5.2 - Current loops adjustments for the 220 VAC amplifier version

Select the right current loops jumpers setting (B1, B2 or B3 position) according to motor and amplifier specifications.

For the BL and MA MAVILOR motor series, the current loops adjustments are made according to following selection table.

AMPLIFIER	4 A	8 A	12 A	17 A	30 A	45 A	60 A	70 A	100 A
MOTOR									
MA 3		B1							
MA 6		B1	B1						
MA 10		B2	B1	B1	B1				
MA 20		B2	B1	B1	B1	B1	B1		
MA 30				B2	B2	B2	B1	B1	
MA 45					B2	B2	B1	B1	B1
MA 55						B2	B2	B2	B1
BL 55-3	B1								
BL 55-5	B1								
BL 71		B2							
BL 72		B2	B1	B1					
BL 73		B2	B1	B1					
BL 74		B2	B1	B1					
BL 111		B1	B1						
BL 112		B2	B2	B1	B2				
BL 113		B3	B3	B2	B2	B2			
BL 114				B3	B3	B2	B2		
BL 115				B3	B3	B2	B2	B2	
BL 141				B2	B2	B2	B1	B1	
BL 142				B3	B3	B2	B2	B1	
BL 143				B3	B2	B2	B1	B1	B1
BL 144				B2	B2	B2	B1	B1	B1

For other motors the adjustment of the current loops according to the **amplifier current rating** and to the **inductance between the motor terminals** is made as follows:

4 A, 8 A, 12 A and 17 A amplifier current ratings

Calculation of $G = 1,4 \times \text{Amplifier current rating (A)} \times \text{Inductance between phases (mH)}$,

If $G < 60$, current loop jumpers (x3) on **B3** position,

If $60 < G < 100$, current loop jumpers (x3) on **B2** position,

If $G > 100$, current loop jumpers (x3) on **B1** position.

30 A, 45 A, 60 A, 70 A and 100 A amplifier current ratings

Calculation of $G = 1,4 \times \text{Amplifier current rating (A)} \times \text{Inductance between phases (mH)}$,

If $G < 100$, current loop jumpers (x3) on **B3** position,

If $100 < G < 250$, current loop jumpers (x3) on **B2** position,

If $G > 250$, current loop jumpers (x3) on **B1** position.

2 - PUTTING INTO OPERATION

The "Enable" input must be open and the analog input command CV open or short-circuited (X4 connector can be disconnected).

Test the auxiliary supply voltage :

Rated value = 230 Vrms single-phase.

Maximum value (must never be exceeded) = 260 Vrms, all mains variation tolerances included.

Switch on the auxiliary supply. The green ON Led must be lit and the UNDERVOLT error must be displayed.

Test the power supply voltage :

- For the 220 VAC amplifier version: **Rated value = 230 Vrms between phases.**

Maximum value (must never be exceeded) = 260 Vrms, all mains variation tolerances included.

- For the 400 VAC amplifier version: **Rated value = 400 Vrms between phases.**

Maximum value (must never be exceeded) = 480 Vrms, all mains variation tolerances included.

Switch on the power supply. The UNDERVOLT error Leds must be unlit. The braking resistor must remain cold.



CAUTION ! This resistor is under high voltage

Check that the amplifiers front panel screws are correctly fastened on the rack.

3 - AMPLIFIER COMMISSIONING AND ADJUSTMENT

3.1 - AMPLIFIER SETUP

Connect the encoder feedback cable between the motor and the amplifier X1 connector.

Connect the X4 command connector : the Enable input must be open, the FC+ and FC- limit switches inputs must be connected and closed, and the analog input command CV must be open or short-circuited.

Connect the serial link RS 232 between the PC and the amplifier X5 connector.

Switch on the PC and the monitor and then start the WINDOWS® interface.

Start the **Visual Drive Setup** software installation and follow the instructions.

Turn on the SMT-BD2 amplifier and start the **Visual Drive Setup** software.

If the message "**No serial communication found**" appears on the screen, click on **OK** and check following points before connecting again the **Visual Drive Setup** software:

- the amplifier is on (green LED **ON** must be lit),
- the amplifier and the PC are correctly connected via the RS 232 link,
- the software configuration (**Com. port and Baudrate**) is correct.

The **Connect** and **Disconnect** commands in the **Setup** menu allow to change the serial link connection from one amplifier to the other without leaving the **Visual Drive Setup** software.



The amplifier command cables (input command, serial link, encoder, HES) as well as the power cables must be connected and disconnected with the amplifier turned off.

3.2 - MOTOR HALL EFFECT SENSORS ADJUSTMENT

If the motor is using Hall Effect Sensors, check that the COM jumpers setting is correct according to the motor HES type (60° or 120°).

Check that the ENABLE input is disabled and the amplifier turned on.

If the “ HES ” error is displayed, turn off the amplifier and check the following points before turning it on again:

- ◆ The HES are correctly wired on the amplifier X1 connector (if 60° type HES are used, check the different HES signals wiring combinations to find the right wiring order).
- ◆ The commutation signal jumpers COM are correctly set according to the HES type.
- ◆ The HES supply voltage value is correct.

Move the motor manually over one revolution, or one pole pitch for a linear motor.

If the “ HES ” error is displayed turn off the amplifier and check the following points before turning it on again:

- ◆ The HES are correctly wired on the amplifier X1 connector (if 60° type HES are used, check the different HES signals wiring combinations to find the right wiring order).
- ◆ The commutation signal jumpers COM are correctly set according to the HES type.
- ◆ The HES supply voltage value is correct.
- ◆ The **Motor encoder resolution** parameter value is correct.

If the motor HES are not working correctly, select the following COM jumpers setting to run the motor without the HES devices.



In this case a motor phasing procedure must be executed at each amplifier power up.

3.3 - ABSOLUTE SINGLE TURN SIN/COS ENCODER ADJUSTMENT

If the motor is using an absolute single turn Sin/Cos encoder (Heidenhain ERN 1085 or compatible), check that the COD and COM jumpers setting are correct.

Check that the ENABLE input is disabled and the amplifier turned on, and move the motor manually over one revolution.

If the “ HES ” error is displayed, turn off the amplifier and check the following points before turning it on again:

- ◆ The Sin/Cos encoder commutation channels are correctly wired on the amplifier X1 connector.
- ◆ The commutation signal jumpers COM are correctly set.
- ◆ The Sin/Cos encoder supply voltage value is correct.
- ◆ The **Motor encoder resolution** parameter value is correct.

3.4 - AMPLIFIER PARAMETER SETTING

Select **Software control** mode and switch on the **Off** position.

Select the motor to be used in the **Motor list** and check the **Motor encoder resolution** value, the **Speed limit** and the **Current limits** according to the motor and amplifier specifications.

Select **Fusing** mode for the I²t protection during all commissioning phases.



If the "incremental encoder" configuration without HES is selected, check that the free motor movement over 1 revolution, or 1 pole pitch for linear motors, is not dangerous for the operator. Then execute the motor phasing procedure ([see section 3.7 of this chapter](#)).

If the motor used is not on the **Motor list**, proceed as described below :

- ◆ Enter the servo motor **Encoder resolution** value.
- ◆ Adjust the **Speed limit** according to the motor and encoder specifications.
- ◆ Adjust the **Current limits** according to the motor and amplifier specifications.
- ◆ Uncouple the motor from the mechanical load and check that the free motor movement over 1 revolution, or 1 pole pitch for linear motors, is not dangerous for the operator. Then execute the **Auto-phasing** procedure.
- ◆ Calculate the **Current phase lead** value (this parameter is especially useful for motors with a low inductance and running at high speeds).

Select the **Encoder output** resolution.



Couple the motor to the load ; in the case of an axis with an unbalanced load (constant torque due to the gravity effect on a vertical axis), [see paragraph 3.5](#) of this chapter. Check that the free motor movement over 1 revolution, or 1 pole pitch for linear motors, is not dangerous for the operator and the machine. Select the most appropriate filter and bandwidth; then execute the **Auto-tuning** procedure.

In case of loud noise in the motor at standstill and when running, check the rigidity of the transmission between motor and load (backlashes and elasticities in gears and couplings). If necessary, renew the **Auto-tuning** procedure by selecting a lower bandwidth (**Bandwidth = Medium or Low**). If the problem remains, renew the **Auto-tuning** procedure by activating the **Antiresonance** filter.



The **Auto-tuning** procedure should be executed in **Software control** mode and **Off** position selected. If the **Auto-tuning** procedure must be executed with the drive controlled by the analog input command CV, the value of the analog input command **MUST** be set at 0 Volt. It is the user's responsibility to take all necessary steps in order to reduce the risk due to uncontrolled axis movements during the **Auto-tuning** procedure.

Test the motor running in both directions with a low digital speed reference value. If required, adjust with more accuracy the speed loop response stability by means of the **Stability gain** buttons or by means of the adjustable gain values.

Short-circuit the "CV" input of the X4 connector or enter a zero speed input command in the NC, if you want to compensate the offset of the whole amplifier + NC system. Then execute the **Offset compensation** procedure or activate the **Offset** button on the amplifier front panel.

3.5 - AMPLIFIER AUTO-TUNING WITH AN UNBALANCED LOAD



In the case of an axis with an unbalanced load (constant torque due to the gravity effect on a vertical axis), the "incremental encoder" configuration without HES is not valid because the motor phasing procedure at power up cannot be executed.

Select **Software control** mode and switch on the **OFF** position.

Execute a first **Auto-tuning** procedure with the motor uncoupled from its mechanical load in order to initialize the gain values before coupling the motor to the load again.

Select the current limitation in **Limiting** mode and select a **PI** or **PI²** speed regulator. Check that the limit switches and the motor brake are correctly operating before starting the **Auto-tuning** procedure.

Move the shaft with a low digital speed reference value up to a maintaining position (far enough from the axis limit switches) where a free movement over 1 revolution, or 1 pole pitch for linear motors, is not dangerous for operator and machine. Then execute the **Auto-tuning** procedure with the motor enabled at its maintaining position (digital speed reference input set at 0). In case of loud noise in the motor at standstill and when running, check the rigidity of the transmission between motor and load (backlashes and elasticities in gears and couplings). If necessary, renew the **Auto-tuning** procedure by selecting a lower bandwidth (**Bandwidth = Medium or Low**). If the problem remains, renew the **Auto-tuning** procedure by activating the **Antiresonance** filter.



During the **Auto-tuning** procedure execution with an unbalanced load (constant torque due to the gravity effect on a vertical axis), a wrong operation may involve dangerous axis movements. It is the user's responsibility to take all necessary steps in order to reduce the risk due to uncontrolled axis movements during the operator's presence in the concerned area.

Test the motor running in both directions with a low digital speed reference value. If required, adjust with more accuracy the speed loop response stability by means of the **Stability gain** buttons or by means of the adjustable gain values.

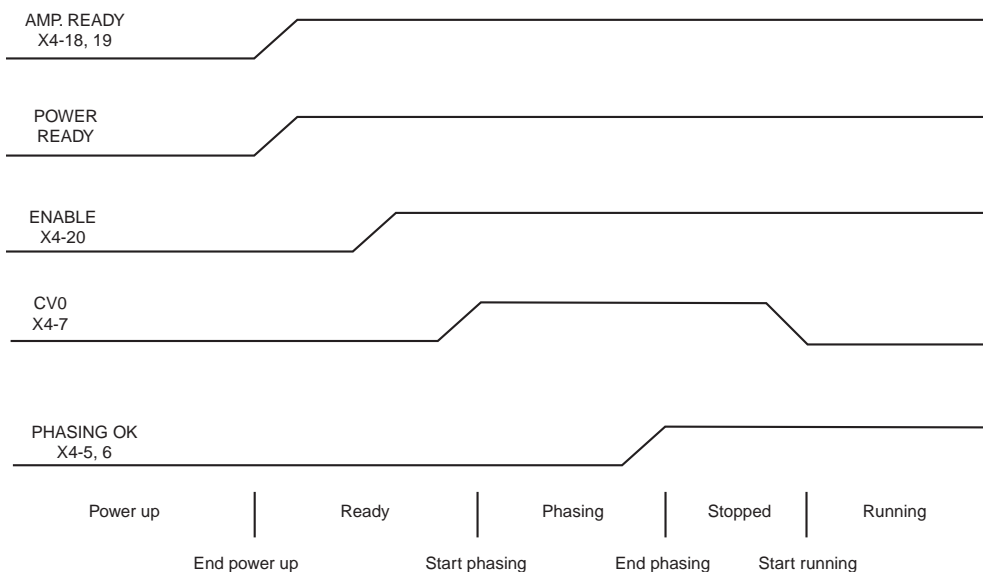
Go back to the motor standstill position before switching on the **OFF** position.

3.6 - SAVING OF THE AMPLIFIER PARAMETERS

Save all parameters in the amplifier EEPROM by means of the **Save parameter to EEPROM** procedure.

3.7 - MOTOR PHASING AT POWER UP

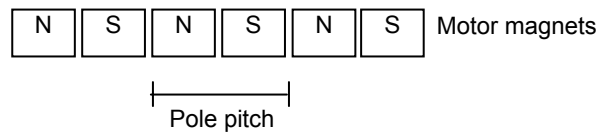
In the "incremental encoder" configuration without HES, the motor phasing procedure must be executed according to the following diagram at each amplifier power up:



In the case of an axis with an unbalanced load (constant torque due to the gravity effect on a vertical axis), the motor phasing procedure is not valid. The motor must be equipped with an incremental encoder + HES or an absolute single-turn Sin/Cos encoder.

3.8 – PARAMETERS ADJUSTMENT TO A LINEAR MOTOR

The **Motor encoder resolution** parameter is calculated as described below:



$$\text{Motor encoder resolution} = 1000 \times \frac{\text{Motor pole pitch (mm)}}{\text{Encoder signal pitch (\mu\text{m})}}$$



1 encoder signal pitch = 4 counting increments

The motor **Maximum speed** parameter value in rpm is calculated according to following formula:

$$\text{Maximum speed (rpm)} = 60 \times \frac{1000}{\text{Motor pole pitch (mm)}} \times \text{Maximum motor speed (m/s)}$$

The linear speed value in m/s is calculated according to following formula:

$$\text{Linear speed (m/s)} = \frac{\text{Motor speed (rpm)}}{60} \times \frac{\text{Motor pole pitch (mm)}}{1000}$$

Chapter 7 – Fault finding

1 - SYSTEM FAULT

If the red **SYS** led is lit when the amplifier is on, the logic board is off duty.

- Check that the EPROM firmware memory is correctly plugged on the amplifier.
- Check for the possible presence of any conducting dust that may involve short-circuits on the amplifier logic board.

2 - STORED FAULTS

If a fault occurs on the amplifier, it can generate the detection of several other faults which are only a consequence of the original one. In order to simplify the diagnostic and the maintenance, the faults are displayed and processed with the priority described below. For safety reasons, the power must be turned off before cancelling some faults that require the handling of the amplifier or the connectors.

2.1 - "BUSY" FAULT

- If the BUSY fault is continuously displayed after power on, the auto-test procedure has failed and the control board is not operating correctly.
- If the BUSY fault is continuously displayed after the starting of the motor phasing procedure by **CVO** at power up ("incremental encoder" configuration without HES) , the procedure has failed because of an external cause and the calculated phase value is wrong. Check that the **Motor encoder resolution** parameter value is correct. Check that the **Motor parameters (Pole pairs and Phase order)** values are correct. Check that the **ENABLE** input is activated. Check that the limit switches inputs are not activated. Check that the motor is not locked and the shaft movement is free during the procedure execution.
- If the BUSY fault is continuously displayed after the execution of the **Auto-phasing** procedure, the procedure has failed because of an external cause and the calculated parameters are wrong. Check that the **Motor encoder resolution** parameter value is correct. Check that the **ENABLE** input is activated. Check that the limit switches inputs are not activated . Check that the motor is unloaded and the shaft movement is free during the procedure execution.
- If the BUSY fault is continuously displayed after the execution of the **Auto-tuning** procedure, the procedure has failed because of an external cause and the calculated parameters are wrong. Check that the **ENABLE** input is activated. Check that the limit switches inputs are not activated. Check that the motor shaft movement is free during the procedure execution.
- If the BUSY fault is continuously displayed after the execution of the **Offset compensation** procedure, the offset is exceeding +/- 0.3 Volts. Check for the voltage value on the analog speed input command CV during the procedure execution. Check that the input command wiring between controller and amplifier answers the requirements of [chapter 4](#) (CV at diff. low of the NC and 0 Volt cable).
- If the BUSY fault is continuously displayed after the execution of the **Cogging torque acquisition** procedure (for rotating motors), the procedure has failed because of an external cause and the cogging acquisition is not valid. Check that the **ENABLE** input is activated. Check that the **CI** and **CVO** inputs are not activated. Check that the limit switches inputs are not activated. Check that the encoder is providing one marker pulse per motor revolution. Check that the motor is unloaded and the shaft movement is free during the procedure execution. Check that the motor current value corresponding to the cogging torque effect is lower than 5% of the amplifier current rating.
- If the BUSY fault is continuously displayed after the execution of the **Linear Cogging acquisition** procedure (for linear motors), the procedure has failed because of an external cause and the cogging acquisition is not valid. Check that the **ENABLE** input is activated. Check that the **CI** and **CVO** inputs are not activated. Check that the positive and negative motor travel limit switches are operating correctly. Check that the encoder is providing one marker pulse over the entire motor travel. Check that the motor is unloaded and the displacement is free during the procedure execution. Check that the motor current value corresponding to the cogging force effect is lower than 5% of the amplifier current rating. Check that the motor travel distance (from the negative to the positive limit switch) is less than 4000000 encoder counting increments.

2.2 - "EEPROM" FAULT

- Check for the presence of the EEPROM and check its correct orientation and mounting.
- If the fault remains, the EEPROM is not correctly initialized (CHECKSUM error) or is not compatible with the amplifier software. In this case, if the EEPROM fault is reset and if then the **Save parameters to EEPROM** procedure is executed, the EEPROM is automatically reinitialized with the amplifier default parameters.

2.3 - "°C MOTOR" FAULT

- If the fault occurs when starting the amplifier:
 - Check the configuration of the **MN** and **OP** jumpers with regard to the type of thermal sensor used in the motor.
 - Check the connection between thermal sensor and amplifier on the front panel connector X1.
- If the fault occurs during the operation:
 - Check the motor temperature value and look for the reason of the motor overheating (mechanical overload, duty cycle too high, ...)

2.4 - "UNDERVOLT." FAULT

- If the fault occurs when starting the amplifier:
 - Check that the power supply is on.
- If the fault occurs during the operation:
 - Check that the power supply connections are correct
 - Check that the power supply voltage value is correct

2.5 - "°C AMPLIFIER" FAULT

Check that the fan and the heatsink configurations are correct with regard of the required rated current ([see current table, Chapter 2, section 1](#)).

Remark : This fault is only valid on amplifiers with current ratings 220/70 and 220/100.

2.6 - "POWER STAGE" FAULT

- If the fault occurs when starting the amplifier:
 - Check the DC bus voltage and the terminal voltage of the power transformer secondary :
 For the 220VAC version of the amplifier DC bus < 370 VDC and V secondary < 260 VAC
 For the 400VAC version of the amplifier DC bus < 800 VDC and V secondary < 480 VAC
- If the fault occurs during the operation:
 - Check the braking system operation during the deceleration phases is correct,
 - Check the sizing of the braking resistor with regard to the deceleration phases.
 - Check for no short-circuit in the motor wiring and at the motor terminals.
 - For amplifiers with 220/04 to 220/60 current ratings and 400 VAC range, check that the fan and the heatsink configuration is correct with regard to the required rated current ([see current table, Chapter 2, section 1](#)).

2.7 - "HES" FAULT

For the "incremental encoder & HES" configuration:

- Check that the HES are correctly wired on the amplifier X1 connector (with 60° type HES you must check the different wiring combinations to found the right wiring order).
- Check that the commutation signal jumpers COM are correctly set according to the HES type.
- Check for the correct HES supply voltage value.
- Check for the correct **Motor encoder resolution** parameter value.
- Check that the HES-amplifier-motor ground connections and shield answer the requirements of [chapter 4](#).

For the "Absolute single turn Sin/Cos encoder" configuration:

- Check that the Sin/Cos encoder commutation channels are correctly wired on the amplifier X1 connector.
- Check that the commutation signal jumpers COM are correctly set.
- Check for the correct Sin/Cos encoder supply voltage value.
- Check for the correct Sin/Cos encoder C channel and D channel signal amplitude value.
- Check that the **Motor encoder resolution** parameter value is correct.
- Check that the encoder-amplifier-motor ground connections and shield answer the requirements of [chapter 4](#).

2.8 - "ENCODER" FAULT

For the "incremental encoder" configuration:

- Check the encoder supply connection on the amplifier connector X1.
- Check that the encoder signal jumpers COD are correctly set.
- Check the encoder A channel, B channel and marker pulse connections on the amplifier connector X1.

If the motor encoder is not providing a marker pulse channel output, the amplifier marker pulse channel must be disabled in order to cancel the "Encoder" fault. In this case the encoder marker pulse jumper ZM must be set in the disabled position as described below.



Encoder marker pulse enabled

ZM



Encoder marker pulse disabled

ZM



When the amplifier marker pulse channel input is disabled, the encoder counting protection is disabled (see section 2.9 "Counting" fault). In this case an incorrect encoder pulses counting can involve uncontrolled motor movements that may be dangerous for operator and machine.

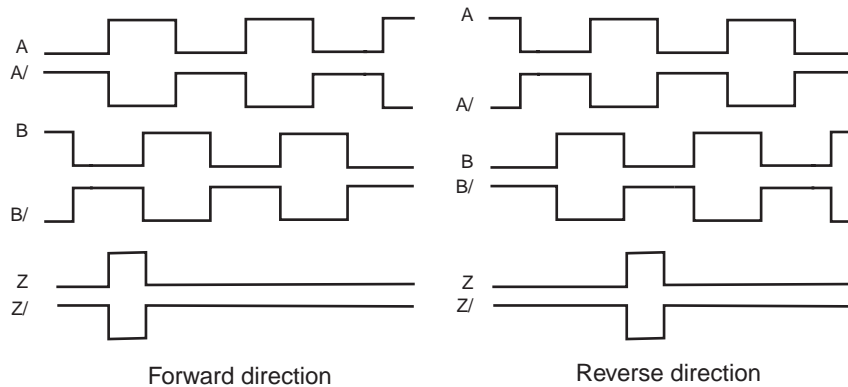
For the "Absolute single turn Sin/Cos encoder" configuration:

- Check the encoder supply connection on the amplifier connector X1.
- Check that the encoder signal jumpers COD are correctly set.
- Check the encoder A channel and B channel connections on the amplifier connector X1.

2.9 - "COUNTING" FAULT

For the "TTL incremental encoder" configuration:

- Check that the encoder signal jumpers COD are correctly set (position B1).
- Check for the correct encoder supply voltage value
- Check for the correct encoder-amplifier-motor ground and shield connections with regard to the recommendations of [chapter 4](#).
- Check for the correct encoder A channel, B channel and Z marker signal waveforms



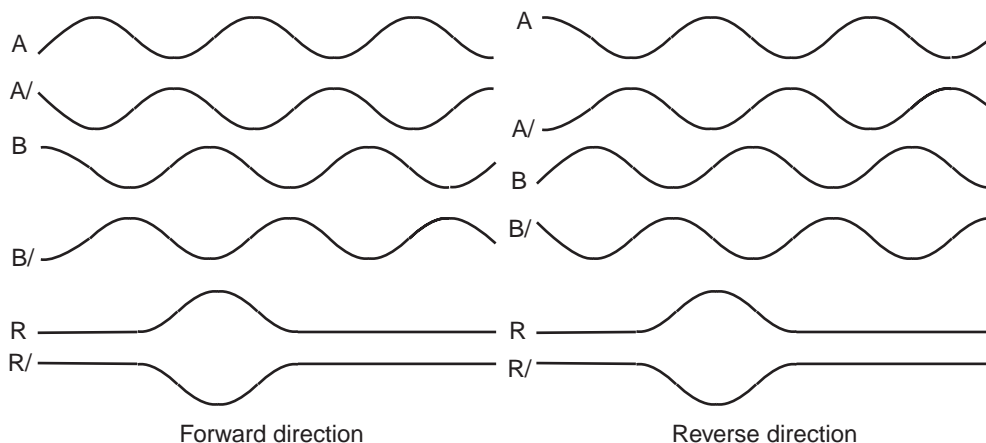
- Check that the following conditions are answered for taking into account the maximum value of the encoder pulse frequency at the maximum motor speed value :
 Max. motor speed (rpm) <math>< 60 \times 10^6 / \text{Number of encoder pulses per revolution}</math>
 Max. motor speed (rpm) <math>< 60 \times \text{Encoder pulse frequency limit (Hz)} / \text{Number of encoder pulses per revolution}</math>
- Check that the **Motor encoder resolution** parameter value is correct.
- Check that the number of encoder pulses between two successive Z marker pulses is an entire multiple of the **Motor encoder resolution** value. If this condition is not fulfilled, the encoder counting protection must be disabled in order to cancel the "Counting" fault. The encoder counting protection can be disabled by disabling the encoder marker pulse by means of the ZM jumper ([see section 2.8 "Encoder fault"](#)).



The encoder counting protection is checking that the encoder pulses count value between two successive Z marker pulses is an entire multiple of the **Motor encoder resolution** value. When the encoder counting protection has been disabled, the amplifier is only checking that the encoder pulses frequency is lower than 1.5 times the maximum encoder frequency. The maximum encoder frequency is calculated into the amplifier according to the **Motor encoder resolution** parameter value and the **Maximum speed** parameter value. In this case, encoder pulse noise at a frequency lower than 1.5 times the maximum encoder frequency may involve uncontrolled motor movements that may be dangerous for operator and machine.

For the Sin/Cos encoder" configuration:

- Check that the encoder signal jumpers COD are correctly set (position B2)
- Check for the correct encoder supply voltage value
- Check for the correct encoder-amplifier-motor ground and shield connections with regard to the recommendations of [chapter 4](#).
- Check for the correct encoder A channel, B channel and R reference signal waveforms.



- Check for the correct **Motor encoder resolution** parameter value.
- Check that the number of encoder pulses between two successive R reference signals is an entire multiple of the **Motor encoder resolution** value. If this condition is not fulfilled, the encoder counting protection must be disabled in order to cancel the "Counting" fault. The encoder counting protection can be inhibited by disabling the encoder reference channel by means of the ZM jumper ([see section 2.8 "Encoder fault"](#)).



The encoder counting protection is checking that the encoder pulse count value between two successive R_{reference} signals is an entire multiple of the **Motor encoder resolution** value. When the encoder counting protection has been disabled, the amplifier is only checking that the encoder pulse frequency is lower than 1.5 times the maximum encoder frequency. The maximum encoder frequency is calculated into the amplifier according to the **Motor encoder resolution** parameter value and the **Maximum speed** parameter value. In this case, encoder pulse noise at a frequency lower than 1.5 times the maximum encoder frequency can involve uncontrolled motor movements that may be dangerous for operator and machine.

2.10 - "I²T" FAULT

- Check the rated current value required with regard to the current table ([see chapter 2, section 1](#)).
- Check the amplifier rated current defined in the **Rated current** parameter with regard to the current required for the operation cycle.

2.11 - "TRACKING" FAULT

Check that the **Speed following error threshold** parameter value is compatible with the required amplifier operating cycle (speed profile and speed loop adjustments). If necessary, increase the **Speed following error threshold** parameter value.

2.12 - "ADC" FAULT

- On SMT-BD2/b amplifiers equipped with the 16 bit ADC option, check for the correct orientation and the correct mounting of the 16 bit ADC component.
- Check that the input command wiring between controller and amplifier corresponds to the recommendations of [chapter 4](#), and repeat the **Offset compensation** procedure.
- If the fault still remains, the amplifier control board is not operating correctly.

3 - OPERATING PROBLEMS

3.1 - MOTOR SUPPLIED, BUT NO TORQUE

- Check the **Maximum current** and **Rated current** parameters.
- Check that the current limitation input (X4 pin 3) is not activated.
- Check that the amplifier is not operating in torque mode (X4 pin 4 active) with zero input command or with CV0 input activated.

3.2 - MOTOR DOES NOT MOVE

- Check that the amplifier is on.
- Check that the power supply is on.
- Check the amplifier fuses (F1 and F2) and the motor connection.
- Check the wiring of the signals FC+, FC- and ENABLE.

3.3 - SHAFT LOCKED, ERATIC OSCILLATIONS OR ROTATION AT MAXIMUM SPEED

- Check that the **Pulse input mode** is disabled in the **Advanced functions** menu.
- Check the encoder wiring on the X1 connector and the mechanical mounting of the encoder on the motor.
- Check the value of the **Motor parameters** parameter in the **Advanced Functions** menu and repeat the **Auto-phasing** procedure, with unloaded motor.

3.4 - DISCONTINUOUS MOTOR ROTATION WITH ZERO TORQUE POSITIONS

Check the connection of the 3 phase cables between motor and amplifier.

3.5 - MOTOR DRIFT WITH ANALOG INPUT COMMAND AT ZERO SPEED

- Check that the input command wiring between the controller and the amplifier corresponds to the recommendations of [chapter 4](#) (CV at diff. low of the NC and 0 Volt cable).
- Check the offset compensation and, if necessary, execute the **Offset compensation** procedure.

3.6 - LOUD CRACKLING NOISE IN THE MOTOR AT STANDSTILL

- Check that the motor-amplifier-controller ground connections correspond to the recommendations of [chapter 4](#).
- Check that the speed input command wiring between controller and amplifier corresponds to the recommendations of [chapter 4](#) and check the shield connection of the encoder cable.

3.7 - LOUD NOISE IN THE MOTOR AT STANDSTILL AND WHEN RUNNING

- Check the rigidity of the mechanical transmission chain between motor and load (backlash and elasticity in the gearboxes and couplings).
- Execute the **Auto-tuning** procedure again by choosing a lower bandwidth (**Medium** or **Low**).
- If the problem remains, renew the **Auto-tuning** procedure by activating the **Antiresonance** filter.

3.8 - POSITION CONTROL NOT POSSIBLE WITH THE NC

- Check for the presence of the A, B and Z signals on the amplifier X2 connector by turning manually the motor shaft and check the wiring between NC and amplifier.
- Check for the correct **Maximum speed** and **Encoder output resolution** parameters.
- Check for the counting direction of the NC with regard to the sign of the speed input command. If there is a reversal, use the function **Reverse Movement** to get a correct operation.

4 - SERVICE AND MAINTENANCE

When exchanging an amplifier on a machine, proceed as follows:

- Check that the new amplifier has the same hardware configuration as the old one,
- Plug in the **parameter EEPROM** (or a copy of it) of the old amplifier on the new one,
- Apply a zero speed input command and start the offset compensation procedure by means of the **Offset** button on the amplifier front panel.

The new amplifier is configured like the old one.

Chapter 8 - Appendix

1 - USE OF THE LIMIT SWITCHES & "CVO" INPUTS

During the amplifier operation in speed mode (**CI** input inactive) the enabling of the **CVO** input immediately stops the motor. The motor is decelerating according to the **Accel/decel time** parameter value. The motor is maintained at standstill while the **CVO** input is activated. During the amplifier operation in torque mode (**CI** input activated) the enabling of the **CVO** input sets the current reference at 0. The current reference is maintained at 0 while the **CVO** input is activated.

During the amplifier operation in speed mode (**CI** input inactive) or in torque mode (**CI** input active), the enabling of the **FC+** limit switch stops any motor displacement in the positive direction and the enabling of the **FC-** limit switch stops any motor displacement in the negative direction. The motor is decelerating with the amplifier **Maximum current** value in order to get the shortest possible braking time.



Positive and negative directions depend on the encoder wiring and on the motor wiring. So, before mounting and wiring the limit switches, it is recommended to find the positive and negative directions of the motor.

2 - USE OF THE "AMP. READY" & "POWER READY" OUTPUTS

When an amplifier fault is released, the **AMP. READY** output is immediately disabled (contact is open). After elimination of the error source, the amplifier can be reset via pins 12 and 13 of the X4 connector.

If the position initialization reference must be kept when a stored fault is released on the amplifier and the power supply turned off, it is necessary to have an auxiliary supply for the logic board which is independent from the power supply. In this case, the **JK** and **KL** jumpers of the logic board allow to inhibit or to release the "Undervolt." fault when the amplifier is turned on.

JK jumper closed and **KL** jumper open configuration :

If the auxiliary supply is turned on before the main power supply, the "Undervolt." fault is displayed and can hide a fault of lower priority. The **AMP READY** and **POWER READY** outputs are both inactive (contact is open) until the power supply is on.

JK jumper open and **KL** jumper closed configuration :

The "Undervolt." fault is inhibited when turning on the auxiliary supply before switching on the main power supply. The **AMP READY** output is then active and **POWER READY** remains inactive (contact open) until the main power supply is on.

3 - SPEED FOLLOWING ERROR PROTECTION

During the amplifier operation in speed mode (**ENABLE** input active and **CI** input inactive), when the speed controller error reaches the **following error threshold** value, the "Tracking" fault is released and the amplifier is disabled. The **Speed following error threshold** parameter value must be adjusted at its minimum value according to the operating cycle in order to detect any uncontrolled motor movements that may be dangerous for operator and machine.



Speed following error protection is inactive during the **Auto-phasing** and the **Auto-tuning** procedures. When the amplifier is operating in torque mode (**CI** input active), the speed following error protection is also inactive.

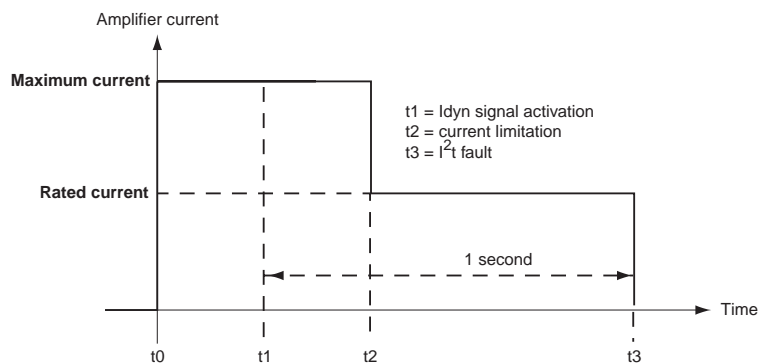
4 – I²t PROTECTION

4.1 – CURRENT LIMITATION IN FUSING MODE

When the amplifier RMS current (I²t) reaches 85 % of the **Rated current**, the Idyn signal output is activated and the I²t error display is blinking on the amplifier front panel. If the RMS current (I²t) has not dropped below 85 % of the **Rated current** within 1 second, the I²t fault is released and the amplifier is disabled (otherwise, the Idyn signal and the blinking I²t error display are both cancelled).

When the amplifier RMS current (I²t) reaches the **Rated current** value, the I²t protection limits the amplifier current at this value.

The amplifier current limitation diagram in an extreme case (motor overload or locked shaft) is shown below.



The maximum current duration before the release of the Idyn signal depends on the value of the **Rated current** and **Maximum current** parameters. This value is calculated as follows:

$$T_{\text{dyn}} (\text{second}) = t_1 - t_0 = 3.3 \times \left[\frac{\text{Rated current (\%)}}{\text{Maximum current (\%)}} \right]^2$$

The maximum current duration before the limitation at the rated current also depends on the value of the **Rated current** and **Maximum current** parameters. This value is calculated as follows:

$$T_{\text{max}} (\text{second}) = t_2 - t_0 = 4 \times \left[\frac{\text{Rated current (\%)}}{\text{Maximum current (\%)}} \right]^2$$

NOTE 1

The above formulas are valid as long as the **Maximum current / Rated current** ratio is higher than 3/2. When the **Maximum current / Rated current** ratio is close to 1, the calculated values of T_{dyn} and T_{max} are quite below the real values. For example when **Maximum current / Rated current** = 1.2, the measured T_{dyn} = 3.4 seconds and the measured T_{max} = 4.4 seconds. When the **Maximum current / Rated current** ratio is equal to 1, the I²t protection is no more disabling the amplifier but the current is limited at the **Rated current** value.

NOTE 2

The amplifier I²t signal can be displayed on the digitizing oscilloscope by selecting the "I²t" signal in the "Channel" menu. The I²t signal threshold values according to the I²t protection mode described above are calculated in the following manner :

$$\text{Idyn signal activation threshold (\%)} = \left[\frac{\text{Rated current (\%)}}{70} \right]^2$$

$$\text{Current limitation threshold (\%)} = \left[\frac{\text{Rated current (\%)}}{50} \right]^2$$

The corresponding amplifier RMS current value can be calculated according to following formula :

$$\text{Amplifier RMS current (\%)} = \left[\text{I}^2\text{t signal value (\%)} \times 50 \right]^{1/2}$$



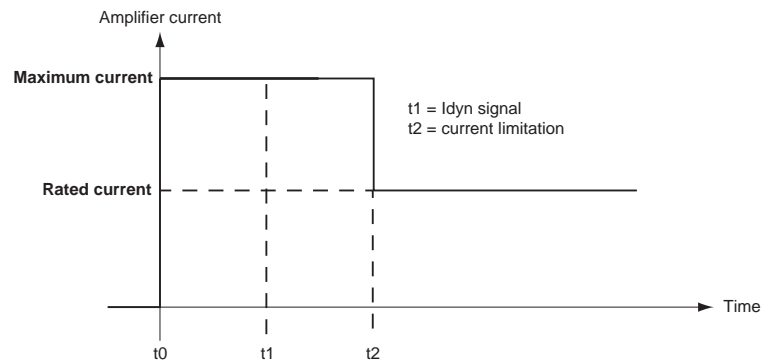
In **Fusing mode**, the amplifier **Rated current** value must be adjusted lower or equal to the **Maximum authorized rated current** of the amplifier (see [Chapter 2, section 1](#)).

4.2 - CURRENT LIMITATION IN LIMITING MODE

When the amplifier RMS current (I^2t) reaches 85 % of the **Rated current**, the I_{dyn} signal output is activated and the I^2t error display is blinking on the amplifier front panel. When the RMS current (I^2t) drops below 85 % of the **Rated current**, the I_{dyn} signal and the blinking I^2t error display are both cancelled.

When the amplifier RMS current (I^2t) reaches the **Rated current** value, the I^2t protection limits the amplifier current at this value.

The amplifier current limitation diagram in an extreme case (motor overload or locked shaft) is shown below.



The maximum current duration before the release of the I_{dyn} signal output ($t1 - t0$) and before limitation at the rated current ($t2 - t0$) is calculated the same way as for the **Fusing** mode.

The I^2t signal threshold values and the amplifier RMS current value on the digitizing oscilloscope, are also calculated the same way as for the **Fusing** mode.



In **Limiting mode**, the amplifier **Rated current** value must be adjusted lower or equal to the **Maximum authorized continuous current** of the amplifier (see [Chapter 2, section 1](#)).

5 - COGGING COMPENSATION OPTION

The cogging torque in brushless permanent magnet rotating motors or the cogging force in brushless permanent magnet linear motors result from the interaction between the permanent magnets and the winding frame slots. This disturbance is due to the difference of reluctance between the copper of the windings and the iron of the slots. For a given motor, the cogging can be easily evaluated by simply moving the motor manually when the amplifier is disabled. The Cogging compensation option available in the SMT-BD2 amplifier allows to cancel the motor cogging effects for specific applications where torque accuracy or force accuracy higher than 1 % are required.

5.1 - AMPLIFIER CONFIGURATION

The cogging compensation option for both rotating and linear motors is available from the 6.1 version of the amplifier firmware memory and the 1.04 version of the Visual Drive Setup software.

Check for the presence of the CT/BD2 memory mounted on the amplifier logic board (see [Chapter 5, section 1 Hardware adjustments](#)).

Check that the encoder marker pulse channel is enabled (ZM jumper in enabled position).

5.2 – COGGING COMPENSATION SETUP FOR ROTATING MOTORS



Cogging torque compensation is only valid on brushless rotating motors equipped with an encoder providing one marker pulse per motor revolution.

Start the amplifier commissioning and adjustment as described in [chapter 6](#).

Uncouple the motor from the load in order to avoid any external disturbance on the shaft during the cogging torque acquisition procedure.

Select the **PI²** controller and the **High Bandwidth**, then execute the **Auto-tuning** procedure.

Execute the **Cogging torque acquisition** procedure. This procedure is taking a few minutes because the motor is moving at low speed over 1 or 2 revolutions in both directions. The acquired cogging torque value is automatically stored in the amplifier CT/BD2 memory during the procedure execution.



The motor shaft must not be disturbed during the cogging torque acquisition procedure.

For checking the cogging torque compensation effects on the motor shaft, proceed as described below :

Switch the amplifier in torque control mode by activating the CI input (X4 connector, pin 4) and short-circuit or open the analog command input CV (X4 connector, pins 15, 16 and 17).

Execute the **Offset compensation** procedure.

Check manually for the reduction of the cogging torque effects, by moving the motor shaft when the **Cogging compensation** command is activated and the amplifier enabled. If some resistant points do remain over one complete motor shaft revolution, renew the acquisition procedure.

Switch off the amplifier and couple the motor to the load.

Switch on the amplifier again, enable the **Cogging compensation** command and execute the **Save parameters to EEPROM** procedure.



At the amplifier power up the cogging torque compensation is only effective after the detection of the first encoder marker pulse.

When changing either the motor, the encoder or the amplifier, the cogging torque acquisition procedure must be renewed.

5.3 – COGGING COMPENSATION SETUP FOR LINEAR MOTORS



Cogging force compensation is only valid on brushless linear motors equipped with an encoder providing only one marker pulse over the entire motor travel. The motor must also be equipped with positive and negative travel limit switches connected on the X4 connector (FC+ and FC- inputs). The maximum motor travel distance (from the negative to the positive limit switch) is limited at 4000000 encoder counting increments. The CT/BD2 memory can store up to 8000 cogging compensation points; so the cogging compensation pitch is equal to the motor travel distance value divided by 8000.

Start the amplifier commissioning and adjustment as described in [chapter 6](#). Check that the motor positive and negative travel limit switches are operating correctly.



In the case of a motor with an unbalanced load (constant force due to the gravity effect on a non horizontal axis), the cogging compensation will include the gravity force. In this case the cogging compensation is only valid if the motor current value corresponding to the gravity force effect is lower than 5% of the amplifier current rating.

Select the **PI²** controller and the **High Bandwidth**, then execute the **Auto-tuning** procedure.

Execute the **Linear cogging acquisition** procedure. This procedure is taking a few minutes because the motor is moving at low speed from one travel limit switch to the other in both directions. The acquired cogging force value is automatically stored in the amplifier CT/BD2 memory during the procedure execution.



The motor must not be disturbed during the cogging force acquisition procedure.

For checking the cogging force compensation effects on the motor shaft, proceed as described below :

Switch the amplifier in force control mode by activating the CI input (X4 connector, pin 4) and short-circuit or open the analog command input CV (X4 connector, pins 15, 16 and 17).

Execute the **Offset compensation** procedure.

Check manually for the reduction of the cogging force effects, by moving the motor when the **Cogging compensation** command is activated and the amplifier enabled. If some resistant points do remain over one complete motor travel, renew the acquisition procedure.

Switch off the amplifier. Then switch on the amplifier again, enable the **Cogging compensation** command and execute the **Save parameters to EEPROM** procedure.



At the amplifier power up the cogging force compensation is only effective after the detection of the encoder marker pulse.

When changing either the motor, the encoder or the amplifier, the cogging force acquisition procedure must be renewed.

6 - AMPLIFIER TYPES

